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ABSTRACT

Reported are 12 studies related to attitudes toward science. Seven of these studies involve preservice elementary teachers. The other five studies relate to attitude development of inservice elementary school teachers. Some additional studies on attitudes are in the summary and conclusions chapter of the document. (PEB)

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MARTHA K. PIPER
Editor
KENNETH D. MOORE
Associate Editor

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Attitudes Toward Science: Investigations

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Foreword

One of the most significant deterrents to effective teaching of science in the elementary schools today is negative teacher attitude. In spite of the nationwide efforts to train teachers to teach the newly developed science curricula, surveys in the sixties revealed that elementary teachers' attitudes toward science did not improve. Recent investigations indicate that lack of interest in science, and less than positive attitudes toward teaching science, remain unchanged. Since it is assumed that these attitudes are not innate, then it is essential for science educators to investigate how positive attitudes can best be developed.

The purpose of this monograph is twofold: (1) to point to the issue of preservice and inservice teachers' negative attitudes toward science which lead to ineffective science teaching and (2) to underscore the variables that develop positive attitudes and thereby encourage effective teaching of science. The science educators who contributed to this monograph are hopeful that their findings will lead to the development of better science education programs for preservice and inservice elementary teachers.

Kenneth D. Moore, Assistant Professor, University of Oklahoma, served as Associate Editor of this monograph. He is presently engaged in needs assessment studies of inservice teachers. He collaborated on a study with Shirley Robard, Professor and Chairperson of Curriculum and Instruction, University of Oklahoma.

Jerry DeBruin, Associate Professor, University of Toledo, is interested in designing and testing the field component aspects of preservice teachers. He contributed a study to this monograph concerning field-based factors affecting preservice teachers' attitudes toward teaching science.

Harold H. Jaus, Assistant Professor, University of Indiana, contributed a study pointing to effects of planning practices on attitudes of preservice teachers. Jaus collaborated with Gerald H. Krockover, Professor, University of Indiana, in investigating attitudes of teachers involved in National Science Foundation implementation programs.

Carl F. Berger, Associate Professor, University of Michigan, contributed a summary of a series of studies concerning teachers' attitudes with new science curricula. He is currently involved in research related to competency-based education.

Linda C. Hough, doctoral student, University of Houston, collaborated with the editor in a research study involving teachers participating in the field component of a science methods course. Mrs. Hough is currently engaged in research concerning the effects of open- and closed-mindedness on attitudes toward science.

MKP, Editor

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I

THE INVESTIGATION OF ATTITUDE CHANGES OF ELEMENTARY PRESERVICE TEACHERS IN A COMPETENCY-BASED, FIELD-ORIENTED SCIENCE METHODS COURSE

MARTHA K. PIPER

Since the teacher generally determines what is taught and how much the student participates in a classroom activity, the very nature of the student's learning experience is greatly affected by the teacher's attitudes and behaviors. In 1958, Todd identified teacher attitude as being a significant deterrent to effective science teaching. Thomson and Thompson (1975) stated that since Todd's investigation, "There is little to indicate that the attitudes of teachers, men or women, have received much revision" (p. 213).

In spite of the development of new science curricula over the past decade, little has happened to change attitudes and allay fears of elementary teachers toward teaching science. (Hurd and Gallagher, 1969) (Ritz, 1969). Butzow stated in 1973 that,

> Many school personnel express a dislike for science that is rooted deeply in failure to learn science when they were elementary, secondary, or college students. This fear stems from the methodology of instruction by which these people were taught (p. 21).

Since it is assumed that attitudes are not innate, then positive attitudes toward teaching science can be learned. Therefore, courses including methodologies of instruction conducive to changing attitudes should be developed and investigated.

One such course was developed around preservice teachers' needs identified through questionnaires and feedback sessions. The preservice teachers indicated that a science methods course successful in teaching them to teach science should include:

1. Being taught on campus as they will be expected to teach;
2. Participating in field experiences which provide practice teaching entire classes;
3. Being informed of behaviors expected of them in teaching science to children.

The attitude changes which occurred in preservice elementary teachers participating in this science methods course were investigated.

The Study

The purpose of this study was twofold: (a) to determine attitude changes of elementary preservice teachers toward teaching science as these students progressed through a competency-based, field-oriented science methods course; and (b) to determine attitude changes toward teaching science of these students as classroom teachers one year later.

Three questions were asked:

1. Do attitudes of preservice elementary teachers toward teaching science change in a positive direction during and following a competency-based, field-oriented science methods course?
2. Are the factors, male or female and past semester hours of science taken in college, related to preservice elementary teachers' attitudes toward science prior to and following a science methods course?
3. If attitudes of preservice elementary teachers change in a positive direction during and following a competency-based, field-oriented science methods course, will these attitudes remain positive over an extended period of time; and if so, will these teachers indicate that they are teaching science?

The subjects of this study were 36 preservice elementary teachers randomly selected from 160 preservice elementary teachers in four sections of an elementary science methods course at the University of Houston.

The Semantic Differential, as established by Osgood, Suci, and Tannenbaum (1956), was the instrument used to collect data. The Semantic Differential uses a set of bipolar adjectives to determine the positive or negative perception an individual associates with a protocol word or phrase. For additional data, the twelve pairs of bipolar adjectives are grouped into three subsets that indicate the degree of activity, potency, and evaluation the individual associates with the protocol word or phrase. Each protocol word or phrase is judged on a seven-step scale between each of the twelve pairs of descriptive adjectives.

The protocol phrases used in this study were:

1. Science Courses in High School
2. Science as Remembered in Elementary School
3. Science Education Methods Courses
4. Science in the News
5. Teaching Science to Children

The 36 randomly selected preservice elementary teachers were given the Semantic Differential (1) prior to the beginning of class activities on campus in 1974; (2) one month later at the end of class activities on campus and prior to the beginning of field experiences; and (3) following field experiences at the end of the science methods course. In addition, one year later, 23 of the original 36 subjects responded to the Semantic Differential along with a questionnaire used to determine if science was being taught in the respondents' classrooms.

The Semantic Differential uses a scale consisting of seven steps between each of the twelve bipolar adjectives. The scale was assigned numerical values from one to seven, one indicating the most positive attitude.

One-way analysis of variance were used to analyze (1) the total responses toward each protocol phrase and (2) the total responses toward each protocol phrase when grouped into the subsets, evaluation, potency, and activity.

The numerals reported in the tables that follow indicate (1) the total mean sums for all responses and (2) the total mean

TABLE 1

PRESERVICE ELEMENTARY TEACHERS' ATTITUDES BEFORE AND FOLLOWING CAMPUS ACTIVITIES

Protocol Phrases		Mean Sum Totals Before (N=36)	Following (N=36)	Probability Level
1. Science in High School	E	13.31	15.33	.02*
	P	15.47	15.53	.92
	A	14.08	15.36	.14
	Total	42.86	15.36	.09
2. Science as Remembered in Elementary School	E	14.11	15.28	.21
	P	17.67	17.03	.23
	A	16.58	16.89	.74
	Total	48.36	49.19	.67
3. Science Education Methods Courses	E	12.33	8.58	.00*
	P	15.28	13.86	.01*
	A	14.39	10.64	.00*
	Total	42.00	33.08	.00*
4. Science in the News	E	15.00	12.00	.82
	P	11.83	16.14	.13
	A	13.67	14.03	.65
	Total	40.50	42.17	.35
5. Teaching Science to Children	E	10.00	10.33	.65
	P	15.58	14.08	.01*
	A	12.67	11.47	.09
	Total	38.25	35.89	.14

E (Evaluation)
P (Potency)
A (Activity)

*Level of Significance at .05

sums for the subsets, evaluation, potency, and activity. Since one indicated the most positive attitude on each scale, the total mean sums that changed from a higher numerical value to a lower numerical value indicated a change to a more positive attitude.

Findings

Attitudes of Preservice Elementary Teachers

Responses indicated both positive and negative changes following one month of campus activities. The negative trends were toward the phrases Science in High School and Science as Remembered in Elementary School. There were statistically significant changes in a positive direction toward Science Methods Courses and toward Teaching Science to Children for one subset (potency) at the end of one month (Table 1). Positive attitudes did not change following the field experiences when compared to attitude following the campus activities. However, following the field experiences when compared to attitudes prior to campus activities, attitudes

TABLE 2

PRESERVICE ELEMENTARY TEACHERS' ATTITUDES BEFORE CAMPUS ACTIVITIES AND FOLLOWING FIELD EXPERIENCES

Protocol Phrases		Mean Sum Totals Before (N=36)	Following (N=36)	Probability Level
1. Science in High School	E	13.31	14.67	.17
	P	15.47	15.17	.55
	A	14.08	15.14	.26
	Total	42.86	44.97	.31
2. Science as Remembered in Elementary School	E	14.11	14.31	.85
	P	17.67	16.67	.14
	A	16.58	17.06	.62
	Total	48.36	48.03	.88
3. Science Education Methods Courses	E	12.33	8.81	.00*
	P	15.28	13.53	.00*
	A	14.39	10.25	.00*
	Total	42.00	32.58	.00*
4. Science in the News	E	11.83	11.69	.86
	P	15.00	15.25	.73
	A	13.67	14.42	.36
	Total	40.50	41.36	.65
5. Teaching Science to Children	E	10.00	9.03	.20
	P	15.58	14.31	.04*
	A	12.67	10.67	.01*
	Total	38.25	34.00	.01*

E (Evaluation)
P (Potency)
A (Activity)

*Level of Significance at .05

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toward Teaching Science to Children were positive in all three subsets (evaluation, potency, and activity). This indicates the field experiences, teaching children, had a positive effect on attitudes (Table 2).

Comparison of Attitudes of Males and Females

There was a statistically significant difference in attitudes of males and females prior to the science methods course toward Science Courses in High School which did not change following the methods course (Table 3). The females appeared to have a more positive attitude toward the science they remembered in high school than the males. Although not significant, it is interesting to note that the males and females began to change their attitudes toward Science Courses in High School in a more negative direction following the science methods course and the degree of difference in the attitudes between the males and females began to widen.

TABLE 3

COMPARISON OF MALE AND FEMALE PRESERVICE ELEMENTARY TEACHERS' ATTITUDES PRIOR TO METHODS AND FOLLOWING METHODS COURSE

Protocol Phrases		Mean Sum Totals Prior Male (N=5)	Female (N=31)	Probability Level	Mean Sum Totals Following Male (N=5)	Female (N=31)	Probability Level
1. Science in High School	E	13.90	9.60	.02*	15.36	10.40	.02*
	P	15.77	13.60	.03*	15.23	14.80	.69
	A	14.71	10.20	.02*	15.52	12.80	.16
	Total	44.39	33.40	.02*	46.10	38.00	.05*
2. Science as Remembered in Elementary School	E	14.13	14.00	.95	14.97	10.20	.04*
	P	17.52	18.60	.30	16.81	15.80	.54
	A	16.32	18.20	.25	17.45	14.60	.20
	Total	47.97	50.80	.45	49.23	40.60	.09
3. Science Education Methods Courses	E	12.71	10.00	.08	8.94	8.00	.55
	P	15.48	14.00	.06	13.77	12.00	.09
	A	14.45	14.00	.66	10.45	9.00	.37
	Total	42.65	38.00	.10	33.16	29.00	.21
4. Science in the News	E	12.00	10.80	.41	11.90	10.40	.39
	P	15.29	13.20	.21	15.16	15.80	.62
	A	13.74	13.20	.74	14.45	14.20	.89
	Total	41.03	37.20	.33	41.52	40.40	.78
5. Teaching Science to Children	E	9.87	10.80	.55	9.13	8.40	.65
	P	15.48	16.20	.48	14.52	13.00	.31
	A	12.77	12.00	.54	10.74	10.20	.73
	Total	38.13	39.00	.78	34.39	31.60	.44

E (Evaluation)
P (Potency)
A (Activity)

*Level of Significance at .05

Comparison of Attitudes of Preservice Elementary Teachers with More than Six Hours of Science and Preservice Elementary Teachers with Six Hours or Less

Attitudes of preservice elementary teachers who had taken more than six semester hours of science in college were compared with the attitudes of preservice elementary teachers who had taken six semester hours of science or less. There were no statistically significant differences between the two groups before the science methods course or following the course. Since there was no distinction made between the kinds of science courses taken, it is not known if that would have made a difference in attitudes.

Attitudes of Preservice Elementary Teachers One Year Later

The attitudes of 23 of the original 36 subjects who responded one year later did not change significantly. The attitudes changed in a positive direction following the science methods course and one year later these attitudes were still positive.

An analysis of the responses to the survey questions is presented in Table 4. Four of the respondents indicated that they were

TABLE 4

PRESERVICE ELEMENTARY TEACHERS' RESPONSES AS TEACHERS ONE YEAR LATER

Questions	Responses (N=23)	
	yes	no
1. I am teaching now.	19	4
2. EED 334 (Science Methods) taught me to teach science to children	18	5
3. I am teaching science to my class.	15	8
4. I need additional help to know how to teach science.	8	15

not teaching. Eighteen responded that the methods course did teach them to teach science. Eight indicated they were not teaching science and needed additional help to teach science to children.

Summary and Conclusions

The analysis of data from this study indicates that the preservice elementary teachers' attitudes toward teaching science were changed in a positive direction by participating in a specially designed course. This concurs with a similar study by Allison and Smith (1974). In addition, these attitudes, once changed, remained fairly constant over a year's time. It should be noted, however, that 35 percent of those who responded after a year's lapse felt they needed additional help to teach science.

There was a difference in the attitudes of males and females toward science before the science methods course began and following it. Even though the male sample was small (N=5) the data do not support Todd's findings in 1958 that women hold attitudes that are more negative than men. It does point to the fact that both men and women appear to hold attitudes that interfere with science teaching but that these attitudes can be changed in spite of past experiences.

Following the science methods course, preservice elementary teachers were asked to list the characteristics of the course which they liked best. The most often mentioned were: (1) the competencies to be mastered in the course were publicly stated; (2) the instructors modeled the behaviors the preservice elementary teachers were expected to demonstrate; (3) campus activities were planned to assist preservice elementary teachers in having successful field experiences; and (4) instructors provided personalized feedback following field experiences.

Further research is needed to determine other characteristics, or combination of characteristics, responsible for changing attitudes toward teaching science.

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II

COMPARISON OF ATTITUDE CHANGES OF PRESERVICE ELEMENTARY TEACHERS TOWARD SCIENCE BETWEEN A TRADITIONAL SCIENCE METHODS COURSE AND A NON-TRADITIONAL SCIENCE METHODS COURSE

MARTHA K. PIPER

The issue over accountability in education is growing and is rapidly concerning both educators and the public. A recent national television program "American Schools: Flunking the Test" stated that the responsibility to train teachers was in the hand of Colleges of Education but that many *traditional* education methods courses did not produce well-prepared, competent teachers. One of the reasons suggested for this lack of training is insufficient classroom experience. The Bicentennial Commission of Education for the Profession of Teaching of the American Association of Colleges for Teacher Education (Howsam, 1976) believes that the design of teacher education should include interlocking relationships between practice and theory.

Child-centered science programs using concrete materials developed in the 1960's demanded real classroom experience using management strategies that were not as important prior to the 1960's when elementary programs were textbook-oriented. Chapman (1971) and Strawitz (1968) looked at the effects of activity-centered methods courses on the attitudes of preservice teachers and reported positive effects. However, the majority of elementary science methods courses have remained traditional in the sense of teaching overviews of current science programs with limited field experiences (Goodlad, 1965).

The following investigation compared attitudes of elementary preservice teachers toward science in a traditional methods course and in what is referred to as a non-traditional, science methods course.

The Study

A traditional elementary science methods course was defined as lecture-oriented with no field experiences. Practice teaching of science activities included the newer elementary science curricula, but was confined to peer teaching on campus. A non-traditional elementary science methods course was defined as competency-based and field-oriented. The amount of field experience comprised 40 percent of the course.

The population used in this study was preservice elementary teachers enrolled in a traditional and a non-traditional science methods course at one university (University A) and a non-tradi-

tional science methods course at another comparable university (University B).

The purpose of this study was to compare attitudes of preservice elementary teachers following participation in science methods courses at two universities. At one university, preservice elementary teachers were enrolled in both a traditional and a non-traditional science methods course. At a nearby comparable university, preservice elementary teachers were enrolled in a non-traditional science methods course.

Osgood's (1957) Semantic Differential was the instrument used to collect data from the preservice elementary teachers enrolled in one traditional science methods and two non-traditional science methods courses.

The Semantic Differential was administered four times:

1. Before and following a traditional science methods course at University A;
2. Following a traditional science methods course and a non-traditional science methods course at University A;
3. Following a traditional science methods course at University A and a non-traditional science methods course at University B; and
4. Following a non-traditional science methods course at University B.

The Semantic Differential uses a seven-step scale between 12 bipolar adjectives. The steps were assigned numerical values one to seven, one being the highest. The subjects responded on the scale to each of five protocol phrases:

1. Science in High School
2. Science as Remembered in Elementary School
3. Science Education Methods Course
4. Science in the News
5. Teaching Science to Children

One-way analysis of variance was used to analyze the total responses. In addition, the adjectives were grouped into subsets, evaluation, potency, and activity. The total responses of the subsets were also analyzed.

The questions asked were:

1. Do the attitudes of preservice elementary teachers toward science change in a positive direction in a traditional science methods course at University A?

2. Is there a difference in attitudes of preservice elementary teachers toward science following a traditional science methods course at University A and a non-traditional science methods course at University A?

3. Is there a difference in attitudes of preservice elementary teachers toward science following a traditional science methods course at University A and a non-traditional science methods course at University B?

4. Is there a difference in attitudes of preservice elementary teachers toward science following a non-traditional science methods course at University A and a non-traditional science methods course at University B?

Findings

ATTITUDES TOWARD SCIENCE BEFORE AND FOLLOWING A TRADITIONAL SCIENCE METHODS COURSE AT UNIVERSITY A

The attitudes of preservice elementary teachers toward Science

TABLE 1

PRESERVICE ELEMENTARY TEACHERS' ATTITUDE CHANGES FOLLOWING A TRADITIONAL SCIENCE METHODS COURSE

Protocol Phrases		Total Mean Sums Before (N=30)	Following (N=30)	Probability Level
1. Science in High School	E	10.90	12.80	.06
	P	14.73	14.90	.81
	A	14.07	14.70	.35
	Total	39.70	42.40	.12
2. Science as Remembered in Elementary School	E	12.30	12.67	.79
	P	15.87	16.93	.34
	A	14.87	14.97	.92
	Total	43.03	44.57	.61
3. Science Education Methods Course	E	11.10	13.63	.01*
	P	14.87	15.87	.15
	A	12.90	15.47	.003*
	Total	38.87	44.97	.002*
4. Science in the News	E	10.27	12.07	.07
	P	14.40	14.87	.62
	A	12.30	13.93	.05*
	Total	36.97	40.87	.08
5. Teaching Science to Children	E	10.47	11.50	.27
	P	15.60	15.90	.70
	A	14.73	14.70	.97
	Total	40.80	42.10	.47

E (Evaluation)
P (Potency)
A (Activity)
*Level of Significance at .05 Level

Education Methods Courses changed in a negative direction (Table 1). The change indicated by the total response was dramatic at the .002 level. The only other statistically significant change was toward Science in the News for the subset activity. This change was also in a negative direction.

ATTITUDES FOLLOWING A TRADITIONAL AND A NON-TRADITIONAL SCIENCE METHODS COURSE AT UNIVERSITY A

A number of attitude changes occurred following participation in different science methods courses, traditional and non-traditional, at the same university (Table 2). The first statistically significant difference was in attitudes toward Science as Remembered in Elementary School. The attitudes of the preservice elementary teachers enrolled in the traditional course were more negative for the subset, activity. The difference in the total mean sum responses toward Science Education Methods Courses and Teaching Science

TABLE 2

COMPARISON OF ATTITUDES BETWEEN NON-TRADITIONAL METHODS AND TRADITIONAL METHODS AT THE SAME UNIVERSITY

Protocol Phrases		Total Mean Sums Traditional A (N=21)	Non-Traditional A (N=30)	Probability Level
1. Science in High School	E	12.80	13.43	.60
	P	14.90	15.81	.23
	A	14.70	14.76	.95
	Total	42.40	44.00	.52
2. Science as Remembered in Elementary School	E	12.67	15.00	.07
	P	16.93	11.95	.36
	A	14.97	17.33	.05*
	Total	44.57	50.29	.07
3. Science Education Methods Course	E	13.63	10.14	.00*
	P	15.87	12.57	.00*
	A	15.47	11.10	.00*
	Total	44.97	33.81	.00*
4. Science in the News	E	12.07	12.91	.40
	P	14.87	14.81	.96
	A	13.93	13.91	.97
	Total	40.87	41.62	.74
5. Teaching Science to Children	E	11.50	9.90	.07
	P	15.90	14.10	.01*
	A	14.70	11.24	.00*
	Total	42.10	35.24	.00*

E (Evaluation)
P (Potency)
A (Activity)

*Level of Significance at .05 Level

to Children was at the .01 level of significance. This indicates a far less positive attitude of those enrolled in a traditional science methods course when compared to those enrolled in a non-traditional science methods course.

ATTITUDES FOLLOWING A TRADITIONAL METHODS COURSE AT UNIVERSITY A AND A NON-TRADITIONAL METHODS COURSE AT UNIVERSITY B

When attitudes of preservice elementary teachers were compared following participation in different science methods courses, traditional and non-traditional, changes did occur. Those enrolled in the traditional science methods course at University A felt less positive toward Science as Remembered in Elementary School. The difference in the total mean sum responses was at the .01 level of significance toward Science Methods Courses and Teaching Science to Children. This is a strong indication that the preservice elementary teachers enrolled in the traditional science methods course

TABLE 3

COMPARISON OF ATTITUDES BETWEEN NON-TRADITIONAL METHODS AND TRADITIONAL METHODS AT DIFFERENT UNIVERSITIES

Protocol Phrases		Total Mean Sums Traditional A (N=36)	Non-Traditional A (N=30)	Probability Level
1. Science in High School	E	12.80	14.67	.07*
	P	14.90	15.17	.62
	A	14.70	15.14	.60
	Total	42.40	44.97	.18
2. Science as Remembered in Elementary School	E	12.67	14.31	.16
	P	16.93	16.67	.16
	A	14.97	17.06	.04*
	Total	44.57	48.03	.18
3. Science Education Methods Course	E	13.63	8.81	.00*
	P	15.86	13.52	.00*
	A	15.47	10.25	.00*
	Total	44.97	32.58	.00*
4. Science in the News	E	12.67	11.69	.67
	P	14.87	15.25	.61
	A	13.93	14.42	.54
	Total	40.87	41.36	.81
5. Teaching Science to Children	E	11.50	9.03	.00*
	P	15.90	14.31	.02*
	A	14.70	10.67	.00*
	Total	42.10	34.00	.00*

E (Evaluation)
P (Potency)
A (Activity)

*Level of Significance at .05 Level

felt less positive following the course than those enrolled in the non-traditional science methods course at University B.

ATTITUDES FOLLOWING NON-TRADITIONAL SCIENCE METHODS COURSES AT UNIVERSITIES A AND B

When attitudes toward science of preservice elementary teachers were compared following participation in non-traditional science methods courses at two universities there were no statistically significant differences. This indicates that non-traditional science methods courses taught at different universities can produce similar attitudes toward science.

Summary and Conclusions

Preservice elementary teachers participating in competency-based and field-oriented science methods courses developed more positive attitudes toward science as compared to those participating in a lecture-oriented course with no field experiences. Science educators need to devise science methods courses that include stated competencies and field experiences as one way to improve attitudes toward science.

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III

THE EFFECT OF A PHYSICS COURSE FOR ELEMENTARY TEACHERS ON ATTITUDES TOWARD SCIENCE OF PRESERVICE ELEMENTARY TEACHERS

MARTHA K. PIPER AND KENNETH D. MOORE

The Commission on Science Education of the American Association for the Advancement of Science (1969) has shown concern for improving elementary teacher attitude toward science by listing Attitude Toward Science as one of the five concerns of elementary teacher preparation. Consequently, among the major goals of elementary teacher preparatory programs should be the goal of improving preservice elementary teacher attitude toward science.

Attempts to develop science skills and a favorable attitude toward science have led to the development and implementation of science courses for preservice elementary teachers (Markle, G. C., and Capie, W. R., 1974); (Thomson and Thompson, 1975). Courses developed jointly between the Science Department and the Education Department avoid the isolation of science and may result in a more positive attitude toward science (Christiansen, 1971). How successful are such courses in generating the desired positive science attitudes? Do preservice elementary teachers have a more positive attitude toward science as a result of having had these science courses?

The Study

This study explored the attitudes toward science of student teachers who had taken a competency-based, field-oriented methods course. In addition, attitudes of the student teachers who had taken the course, Physics for the Elementary Teacher, were compared with those who had not taken the course.

1. Do elementary student teachers who have taken a competency-based, field-oriented methods course have a positive attitude toward activity, hands-on science teaching?

2. Is there a significant difference in attitude toward activity, hands-on science teaching for elementary student teachers who have had a Physics for the Elementary Teachers course and elementary student teachers who have not?

A review of ten years of research shows that numerous instruments that measure various aspects of attitudes toward scientists, science, and the scientific enterprise have been constructed and utilized in attitude research. These include instruments developed by Lowery (1968), Vitogan (1967), Schwirian (1963), Moore and

Sutman (1970), Steiner (1973), Tilford (1973), Shrigley and Johnson (1974) and Shrigley (1974). Although the instruments prepared by the writers cited above are quite satisfactory for measuring many aspects of science attitude, none of the instruments were satisfactory for measuring attitude toward activity, hands-on science teaching. In addition, none of the developed instruments located could be used to compare attitudes towards the different elementary preservice methods courses.

The *Piper Attitude Toward Science Scale* (PATSS) was developed for use in this study. The PATSS consists of 26 items designed to elicit attitude toward teaching science using an activity, hands-on process approach. Of the 26 items included in the PATSS, five items relate to specific elementary methods courses. The list of 26 items was generated by interviewing science educators, generic specialists and interested students at the University of Houston.

The reliability estimate of the PATSS using Hoyt's analysis of variance method is .901. This method yields a conservative estimate based on the amount of correlation among the item responses within one test. This method was chosen because the test-retest method was not possible, and equivalent forms were not available.

The validity of the PATSS was tested through the use of the factor analysis procedure. The application of the varimax rotation procedure indicated the presence of five interpretable, science-related factors which accounted for 49.1 percent of the total variance.

In its final form, the PATSS consists of 26 items with each statement being followed by a positive and negative response component. The final form of the PATSS follows:

Attitudes Toward Science Mark an X in the box by the statement that best represents how you feel.	Strongly Agree	Agree	Disagree	Strongly Disagree
1. I have always liked science as a subject.				
2. I have always thought I would like to teach science.				
3. I liked science best of my methods courses.				
4. I liked math best of my methods courses.				
5. I liked reading best of my methods courses.				

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	Strongly Agree	Agree	Disagree	Strongly Disagree
6. I liked language arts best of my methods courses.				
7. I liked social studies best of my methods courses.				
8. I would like to teach science now that I have had the science methods course.				
9. I do not like science since taking the methods course.				
10. I like science since taking the methods course.				
11. My cooperating teacher teaches science almost never.				
12. My cooperating teacher teaches science sometimes.				
13. My cooperating teacher teaches science at least twice a week or more.				
14. My cooperating teacher likes to teach science.				
15. I think children should be involved in activities with materials.				
16. I do not know how to teach science activities to a classroom of children.				
17. I like teaching science activities to a classroom of children.				
18. I would need expensive materials to teach science activities.				
19. I prefer having children read their science textbook.				
20. My cooperating teacher prefers having children read their science textbook.				
21. Elementary children should learn scientific facts in school.				

	Strongly Disagree	Disagree	Agree	Strongly Agree
22. Elementary children should practice science processes in school.				
23. I plan never to teach science activities when I have my own class.				
24. I plan to teach science activities sometimes when I have my own class.				
25. I plan to teach science activities at least twice a week or more when I have my own class.				
26. I like to teach science activities to children since taking the science methods course.				

☐ Check if you took Physics for the Elementary Teacher

_____Social Security Number

The sample in this study consisted of the entire population (N=160) of elementary student teachers graduating from the University of Houston in the Spring of 1975. They had taken the competency-based, field-oriented science methods course at the University of Houston the previous semester. Additionally, approximately one-quarter of the student teachers had successfully completed the course Physics for the Elementary Teacher during their freshman or sophomore year at the University of Houston.

The PATSS was mailed to the 160 elementary student teachers. Returns were received from 111 respondents which represented 69.3 percent of the student teacher sample. Of the 111 instruments returned, 99 returns (61.9 percent) were found to be usable. Thirty of the usable returns were randomly selected to check the reliability and validity of the PATSS. The remaining 69 usable returns were used in the analysis of data.

An inspection of the 69 returns which were used in the data analysis showed that 15 respondents had completed the course Physics for the Elementary Teacher. Hence, the no physics group consisted of 54 subjects and the physics group consisted of 15

subjects. The student teacher responses were measured in terms of a weighted value, one through four, which corresponded to the four columns on the PATSS (one corresponded to Strongly Disagree and *four corresponded to Strongly Agree*).

The mean for each item in the PATSS was calculated for the no physics group and the physics group. In addition, the total PATSS mean score was calculated for each group. One-way analyses of variance were used to test for a significant difference between the group means on each item in the PATSS and the total PATSS mean scores.

Findings

Attitudes of Student Teachers

The total sample means for each of the 26 items included in the PATSS and the total PATSS mean score are presented in Table 1. The evidence presented in Table 1 seems to support the conclusion that a competency-based, field-oriented science methods course will result in a favorable attitude of student teachers toward activity, hands-on science teaching. An inspection of the means of those items related to science teaching (items 1, 2, 8, 9, and 10) indicate that the competency-based, field-oriented science methods course resulted in a favorable attitude toward science teaching. In addition, the means of the responses to those items related to *doing* rather than *reading about* science (items 15, 17, 19, 21, 22, 25, and 26) indicate that a competency-based, field-oriented science methods course instills in students a desire to teach science through science activities rather than through the utilization of a science textbook.

Of special interest among the student teacher responses were the responses to those items related to the cooperating teachers' teaching of science (items 11, 12, 13, 14, and 20). The means for these five items fall between 2.28 and 2.71 which suggests a neutral attitude on these items. This neutral attitude might be due to a protective feeling on the part of the student teachers toward the science teaching of their cooperating teachers and toward themselves while working with their respective cooperating teacher.

Also of interest among the items on the PATSS was the student teacher responses to those items which relate to elementary methods courses (items 3, 4, 5, 6, and 7). Although the science methods course mean is somewhat higher than the means of the other methods courses, the means for all of the methods courses lie between 2.13 and 2.83. This suggests that the student teachers could not decide which of their methods courses they liked best.

The means for the 26 items in the PATSS and the total PATSS means for the no physics group and the physics group are presented in Table 2. The no physics group and the physics group differed

significantly at the .05 level on items 18, 19, and 22. The physics group had the more positive attitude on all three significant items.

The responses to item 18 are quite surprising in that there is a tendency for the no physics group to feel a need for expensive materials to teach science activities. This tendency may be due to the extensive use of the SAPA-II materials in the science methods course.

The Physics Group and the No Physics Group

A comparison of the means of the two groups on those items related to the teaching of science (items 2, 8, 9, 15, 16, 17, 18, 19, 21, 22, 25, and 26) shows that the physics group, in general, had the more favorable attitude toward activity, hands-on science teaching. Although the physics group had the more favorable attitude toward activity, hands-on science teaching, this group tended to feel that elementary children should learn scientific facts in school. This is not surprising in that the physics group was introduced to more scientific facts than was the no physics group. The responses to item 21, therefore, suggest that if elementary teachers are introduced to scientific facts they tend to place more emphasis on scientific facts in teaching science.

Even though the physics group tended to have a more positive attitude toward activity, hands-on science teaching, the difference between the total PATSS means for the two groups proved not to be significant at the .05 level.

Summary and Conclusions

A major implication of this study is that student teachers' attitudes toward science can be enhanced by involving these preservice elementary teachers with direct, hands-on science teaching experiences. This suggests that elementary science methods courses should be designed to improve attitudes by utilizing hands-on science materials in actual teaching situations.

The evidence indicates preservice elementary teachers feel that scientific facts are important in teaching science to children. Therefore, a second implication of this study is that preservice elementary teacher attitudes toward science can be improved by involving the preservice elementary teachers in science courses specifically designed for them.

TABLE 1

MEAN ATTITUDE TOWARD SCIENCE OF ELEMENTARY PRESERVICE STUDENT TEACHER SAMPLE

	Item	Mean (N=69)
1.	I have always liked science as a subject.	2.88
2.	I have always thought I would like to teach science.	2.54
3.	I liked science best of my methods courses.	2.83
4.	I liked math best of my methods courses.	2.13
5.	I liked reading best of my methods courses.	2.58
6.	I liked language arts best of my methods courses.	2.52
7.	I liked social studies best of my methods courses.	2.35
8.	I would like to teach science now that I have had the science methods course.	3.04
9.	I do not like science since taking the methods course.	1.35
10.	I like science since taking the methods course.	3.12
11.	My cooperating teacher teaches science almost never.	2.35
12.	My cooperating teacher teaches science sometimes.	2.56
13.	My cooperating teacher teaches science at least twice a week or more.	2.57
14.	My cooperating teacher likes to teach science.	2.71
15.	I think children should be involved in activities with materials.	3.87
16.	I do not know how to teach science activities to a classroom of children.	1.54
17.	I like teaching science activities to a classroom of children.	3.46
18.	I would need expensive materials to teach science activities.	1.59
19.	I prefer having children read their science textbook.	1.48
20.	My cooperating teacher prefers having children read their science textbook.	2.28
21.	Elementary children should learn scientific facts in school.	2.72
22.	Elementary children should practice science processes in school.	3.48
23.	I plan never to teach science activities when I have my own class.	1.32
24.	I plan to teach science activities sometimes when I have my own class.	2.71
25.	I plan to teach science activities at least twice a week or more when I have my own class.	3.41
26.	I like to teach science activities to children since taking the science methods course.	3.29
Total PATSS		66.87

TABLE 2

COMPARISON OF MEAN ATTITUDE OF NO PHYSICS GROUP AND PHYSICS GROUP

	Item	No Physics Mean (N=54)	Physics Mean (N=15)	Probability
1.	I have always liked science as a subject.	2.83	3.07	.28
2.	I have always thought I would like to teach science.	2.46	2.80	.14
3.	I liked science best of my methods courses.	2.72	3.20	.09
4.	I liked math best of my methods courses.	2.09	2.27	.46
5.	I liked reading best of my methods courses.	2.57	2.60	.91
6.	I liked language arts best of my methods courses.	2.59	2.27	
7.	I liked social studies best of my methods courses.	2.37	2.27	.68
8.	I would like to teach science now that I have had the science methods course.	3.00	3.20	.37
9.	I do not like science since taking the methods course.	1.59	1.40	.21
10.	I like science since taking the methods course.	3.07	3.27	.33
11.	My cooperating teacher teaches science almost never.	2.41	2.13	.29
12.	My cooperating teacher teaches science sometimes.	2.61	2.40	.32
13.	My cooperating teacher teaches science at least twice a week or more.	2.56	2.60	.87
14.	My cooperating teacher likes to teach science.	2.76	2.53	.37
15.	I think children should be involved in activities with materials.	3.87	3.87	.97
16.	I do not know how to teach science activities to a classroom of children.	1.59	1.33	.13
17.	I like teaching science activities to a classroom of children.	3.43	3.60	.31
18.	I would need expensive materials to teach science activities.	1.70	1.20	.00*
19.	I prefer having children read their science textbook.	1.56	1.20	.05*
20.	My cooperating teacher prefers having children read their science textbook.	2.30	2.20	.75

TABLE 2 (CONTINUED)

COMPARISON OF MEAN ATTITUDE OF NO PHYSICS GROUP AND PHYSICS GROUP

Item	No Physics Mean (N=54)	Physics Mean (N=15)	Probability
21. Elementary children should learn scientific facts in school.	2.69	2.87	.45
22. Elementary children should practice science processes in school.	3.41	3.73	.03*
23. I plan never to teach science activities when I have my own class.	1.37	1.13	.15
24. I plan to teach science activities sometimes when I have my own class.	2.80	2.40	.09
25. I plan to teach science activities at least twice a week or more when I have my own class.	3.37	3.53	.34
26. I like to teach science activities to children since taking the science methods course.	3.22	3.53	.13
Totals PATSS	66.94	66.60	.81

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IV

FACTORS UNDERLYING STUDENT TEACHERS' ATTITUDES TOWARD SCIENCE IN A PRESERVICE ELEMENTARY PROGRAM

KENNETH D. MOORE AND MARTHA K. PIPER

Elementary teachers have a negative attitude toward science and science teaching. Recently, science educators have directed much attention and research toward determining the science attitudes of preservice elementary teachers (Billeh and Zakbariades, 1975; Butzow and Davis, 1975; Shrigley, 1974; Tilford, 1973). This research has led to the development and implementation of new science methods courses and science for elementary teachers' courses that propose to improve the science attitudes of preservice elementary teachers (Kennedy, 1973; Markle and Capie, 1974; Thomson and Thompson, 1975; Pempek, 1973).

Are science methods and science courses the only factors that affect preservice elementary teachers' attitudes toward science? It may be that other factors exist which are related to the science attitudes of preservice elementary teachers. The purpose of this study was to identify the factors underlying student teacher attitudes toward activity, hands-on science teaching.

Ninety-nine elementary education majors who were student teaching during their senior year at the University of Houston participated in this study. All respondents had taken the competency-based, field-oriented science methods course at the University of Houston. In addition, 15 of the respondents had successfully completed the science course Physics for the Elementary Teacher.

The student teacher responses to the *Piper Attitude Toward Science Scale* (PATSS) which was developed and used in a study to determine the effect of a physics course for elementary teachers on preservice elementary teacher attitudes toward science (see pp. 21-23 of this monograph) were used to infer factors underlying preservice elementary teachers' attitudes toward activity, hands-on science teaching. It was felt that the student teacher responses to the 26 items included in the PATSS would be representative of preservice elementary teachers.

The student teacher responses to the 26 items in the PATSS were measured in terms of a weighted value, one through four, which corresponded to the four response choices (Strongly Agree, Agree, Disagree, and Strongly Disagree) available to the student teachers. The response Strongly Disagree was assigned weight value one, and the response Strongly Agree was assigned weight value four.

In order to test for factors underlying preservice elementary

student teachers' attitudes toward activity, hands-on science teaching, the student teacher responses to the PATSS were submitted to factor analysis utilizing principal components factor extraction and orthogonal rotation by the Varimax criterion.

Findings

Nine factors, accounting for 71.8 percent of the total PATSS variance, were extracted by the Varimax criterion. Twenty-four of the items loaded singly and over 0.450 on the extracted factors.

A sufficient number of high loading items to satisfactorily interpret the factors occurred on five of the nine factors. An examination of the interpretable factors indicated the presence of a major factor which accounted for 20.1 percent of the total variance in the PATSS. In addition, the remaining four minor interpretable factors, together, accounted for an additional 29.9 percent of the total variance.

The major factor, factor 1, was named Science Methods Activities. Items loading high on this item (Table 1) reflect a liking for science and teaching science activities as a result of the science methods course. It should also be noted that those particular items which deal with a negative feeling toward science and teaching science activities had a high negative loading on this factor.

While each of the other four interpretable factors accounted for an appreciably smaller portion of the total variance, together they represent a substantial portion of the total variance. These four minor factors were named

Factor 2. Science Activities During Student Teaching.

Factor 3. Science Orientation.

Factor 4. Language Arts and Social Studies Methods Activities.

Factor 5. Mathematics Activities.

Factor 2, Science Activities During Student Teaching accounted for 9.2 percent of the total variance. Items loading high on this factor relate to the amount of science taught by the student teacher's cooperating teacher and to the cooperating teacher's satisfaction with science teaching.

Factor 3, Science Orientation accounted for 7.5 percent of the total variance. Items loading high on this factor pertain to the student teacher's past feelings toward science and science teaching. The items loading high on this factor also seem to be related to the student's past science courses which emphasized science through direct hands-on science activities.

Factor 4, Language Arts and Social Studies Methods Activities accounted for 6.2 percent of the total variance. The high loading

TABLE 1

HIGHEST LOADING ITEMS ON THE MAJOR FACTOR "SCIENCE METHODS ACTIVITIES"

Item	Loading
I like science since taking the methods course	.886
I like to teach science activities to children since taking the science methods course	.841
I would like to teach science now that I have had the science methods course	.839
I liked science best of my methods courses	.815
I like teaching science activities to a classroom of children	.719
I do not know how to teach science activities to a classroom of children	−.669
I do not like science since taking the methods course	−.758

items on this factor seem to be related to activity experiences received in Language Arts Methods and Social Studies Methods.

Factor 5, Mathematics Activities accounted for 6.1 percent of the total variance. Items loading high on this factor indicate that past mathematics experiences have a detrimental effect on teaching activity, hands-on science teaching.

Summary and Conclusions

The purpose of this study was to identify the factors related to preservice elementary teachers' attitudes toward activity, hands-on science teaching. The findings suggest that preservice elementary teachers' attitudes toward activity, hands-on science teaching are related to five factors. These factors include: 1) science methods activities, 2) science activities during student teaching, 3) science orientation, 4) language arts and social studies methods activities, and 5) mathematics activities.

Although science methods activities appear to be the major contributor to preservice elementary teachers' attitudes toward activity, hands-on science teaching, the evidence seems to suggest that researchers should direct their attention toward other areas in addition to science methods and science content courses for elementary teachers in order to improve preservice elementary teachers' attitudes toward activity, hands-on science teaching. Specifically, these additional areas include providing better science experiences during student teaching, improving Language Arts and Social Studies experiences, and improving Mathematics experiences.

Of interest for future investigation is the extent to which the factors identified in this study affect preservice elementary teachers'

attitudes toward activity, hands-on science teaching. It might be that educators could do more to improve attitudes toward activity, hands-on science teaching by directing their attention toward areas other than science methods and science content courses for elementary teachers.

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V

FIELD-CENTERED PRESERVICE ELEMENTARY SCIENCE AND CONTENT READING METHODS

KENNETH D. MOORE AND SHIRLEY ROBARDS

Numerous criticisms have been directed toward the higher education institutions that prepare teachers for the elementary classroom (Borg, 1975; Fuller, 1969; Krajewski, 1974; Popham, 1974; and Smith, Otto, and Harty, 1970). Prominent among the criticisms are those voiced by preservice teachers regarding elementary preservice methods courses (Spillane and Levenson, 1976).

The following remarks are indicative of the dissatisfaction of preservice elementary teachers with their methods courses. "Methods courses do not deal with the reality of the classroom. Methods courses don't really have anything to do with teaching—it's all theory. Methods courses are too general—they don't deal with my grade level interest or even with real kids. Teach in an open concept classroom or work with minority children? How should I know; I've had no experiences with either. My senior year and I haven't worked with an entire class of children; hope I can apply all the methods theory since it's too late to change majors." These voiced feelings from preservice elementary teachers too often are the result of less than positive attitudes toward elementary preservice methods courses and education courses in general.

The issue of preservice elementary teachers lacking experiences in the real affairs of schools is a serious shortcoming (Silberman, 1970). Field experiences are not magical; however, they are valuable when carefully integrated with knowledge and skills (Howsam, et al, 1976, p. 93).

The cries for relevance between theory and practice to improve the effectiveness of elementary preservice methods courses are being heard by some teacher educators, but not by everyone (Pomeroy, 1975). A review of the literature revealed little empirical evidence to support field-centered programs in elementary preservice methods courses where theoretical constructs may be implemented in actual classrooms prior to student teaching.

Can teacher preparatory institutions provide preservice elementary teachers with the necessary philosophical framework and methodological skills utilizing a course design which will result in positive attitudes toward preservice methods courses and their content? Can teacher preparatory institutions provide preservice experiences which will enable preprofessional teachers to function effectively with multicultures in a variety of elementary school environments? Field-centered, elementary preservice science and

content reading methods courses were developed and implemented at The University of Tulsa in order to resolve such issues.

The field-centered science and content reading methods courses at The University of Tulsa consist of five phases. These phases are:

PHASE 1. CAMPUS ACTIVITIES I. The focus during this initial 8-week period is the acquisition and synthesis of science and content reading methods, theory, and practices. During this phase, university instructors model and provide guided activities so that the preservice teachers acquire the identified competencies for effective science and content reading teaching.

PHASE 2. FIELD EXPERIENCE I. The focus during this 2-week period is directed toward providing preservice teachers with direct experiences in the first of three types of elementary school settings (open-concept, self-contained, and multicultural settings). Preservice teachers spend a period of 6 hours in this phase. During this 6-hour period, each preservice teacher observes in assigned classrooms and prepares and implements a 30-minute science lesson to an entire class. Each preservice teacher also observes, prepares, and implements a 30-minute content reading lesson to an entire class. No formal evaluation of teaching competencies takes place during this first field experience. However, each preservice teacher is provided informal feedback on the identified science and content reading competencies by university instructors, classroom teachers, and peers.

PHASE 3. FIELD EXPERIENCE II. The focus during this 2-week period is directed toward providing preservice teachers with direct experiences in the second of three types of elementary school settings (open-concept, self-contained, and multicultural settings). The requirements and responsibilities of the preservice teachers are the same as that of Field Experience I. Again, only informal feedback is provided in Field Experience II.

PHASE 4. FIELD EXPERIENCE III. The focus during this 2-week period is directed toward providing preservice teachers with direct experiences in the third of three types of elementary school settings (open-concept, self-contained, and multicultural settings). The requirements and responsibilities of the preservice teachers are identical to those of Field Experiences I and II. Formal evaluation of teaching competencies takes place during this phase. Each preservice teacher is evaluated by university instructors, classroom teachers, and peers on the demonstration of the identified science and content reading competencies.

PHASE 5. CAMPUS ACTIVITIES II. The focus during this final week is directed toward discussion of the Field Experiences. These campus discussion seminars center on problems encountered

during the Field Experiences, teaching methods, strategies, and other topics related to teaching science and content reading in the three different elementary school settings. In addition, final evaluation of the preservice teachers' acquisition of the science and content reading teaching competencies takes place during this final phase.

The Study

The purpose of this study was to investigate the effect of field-centered methods courses as compared to campus-centered methods courses on attitudes toward preservice elementary teachers. Additionally, this study was designed to explore the following questions:

1. Do elementary preservice students have a positive attitude toward field experiences upon completion of field-centered science methods course?

2. Do elementary preservice students have a positive attitude toward field experiences upon completion of field-centered content reading methods course?

Two groups of preservice elementary teachers were included in the study. The control group consisted of 13 senior preservice elementary student teachers who had successfully completed both the campus-centered science methods course and the campus-centered content reading methods course at The University of Tulsa. The experimental group consisted of 54 junior and senior preservice elementary teachers enrolled in the two field-centered methods courses. Fifteen subjects in the experimental group were enrolled in both the field-centered science methods course and the field-centered content reading methods course. These students taught a 30-minute science lesson and a 30-minute content reading lesson in the same school during each field experience phase.

A revised form of the *Robards Attitude Profile* (RAP) (Robards, 1975) was used to elicit the preservice teachers' attitudes toward the different methods courses. The revised RAP consists of 16 items with each item being followed by a positive and negative response component. The first 10 items included in the RAP are related to general attitudes toward science and content reading methods courses. Items 11 through 16 are related to the field experiences which were part of the field-centered methods courses.

The RAP was administered to the control group (campus-centered methods group) during their last student teaching seminar in the Fall Semester of 1975. The RAP was completed by the experimental group (field-centered methods group) during the last class period of the methods courses in the Fall Semester of 1975. In order

to obtain honest responses, names were not requested from the respondents.

The response choices available to the respondents were Strongly Agree, Agree, Disagree, Strongly Disagree, and Not Applicable. The preservice elementary teacher responses were measured in terms of a weighted value, one through four, which corresponded to the four attitude level response choices available to the respondents (one corresponded to Strongly Agree and four corresponded to Strongly Disagree).

The data from the weighted responses to the first 10 items included in the RAP were analyzed by one-way analysis of variance with two treatment levels. In addition, the mean attitude scores for items 11 through 15 were calculated for the field-centered methods group in order to test for a positive attitude toward the field experiences.

Findings

The means and probability levels for the field-centered science methods group and the campus-centered science methods group on the 10 RAP items related to the methods courses are presented in Table 1. The field-centered group and campus-centered group differed significantly at the .05 level on items 2, 3, 4, and 9. The data presented in Table 1 reveal that the field-centered group had the more positive attitude on the four significant items. An inspection of items 2, 3, and 4 indicate that the field-centered group felt that the field-centered science methods course was the more relevant to teaching science in the elementary school. Additionally, the results obtained on item 9 suggest that the field-centered group felt more responsible for their own learning. This feeling of responsibility may be attributed to the fact that the field-centered group developed and taught science lessons to children in a variety of elementary school classrooms.

Although not statistically significant, the field-centered group also had a more positive attitude on items 1, 7, and 10. An examination of these items suggests that the field-centered group found the teaching of science lessons in the classroom more demanding and applicable to teaching than were their other undergraduate courses.

An inspection of items 5, 6, and 8 suggests that the groups felt no difference existed on these items. The reactions to items 6 and 8 are not surprising in that both methods courses used a hands-on, activity approach to science teaching. The responses to item 5 are surprising in that the field-centered group were involved in field experiences while the campus-centered group had no field experiences. It may well be that the students were reacting to the campus components of the methods courses only on this item.

TABLE 1

COMPARISON OF MEAN ATTITUDE OF CAMPUS-CENTERED AND FIELD-CENTERED SCIENCE METHODS GROUPS

Item	Campus-Centered Mean (N=13)	Field-Centered Mean (N=26)	Probability
1. To me the objectives of the course were clearly stated.	2.08	1.96	.67
2. To me the content of the course was adequate.	1.92	1.42	.02*
3. To me the clarity and purpose of the assignments in the course were reasonable.	2.00	1.46	.03*
4. Overall, the course will be useful to me as a beginning teacher.	1.67	1.22	.03*
5. The teaching techniques used in the course were similar to other courses I have taken at this University.	2.25	2.35	.75
6. I felt free to express my opinion in the course.	1.58	1.65	.79
7. The instructor demonstrated concern for the quality of teaching.	1.58	1.26	.19
8. The instructor related this course to other fields of study.	1.33	1.39	.77
9. The instructor encouraged students to think independently.	1.67	1.22	.01*
10. The intellectual demands of this course were more than those of most undergraduate courses.	2.69	2.23	.09

* Significant at .05 level.

The means and probability levels for the field-centered content reading group and the campus-centered content reading methods group on the 10 RAP items related to the methods courses are presented in Table 2. The field-centered group and the campus-centered group differed significantly at the .05 level on items 1, 2, 4, 5, and 6. The data presented in Table 2 indicate a more positive attitude for the field-centered group.

Further analysis of items 1, 2, 4, and 6 shows that the field-centered group felt that the field-centered content reading methods course was the more applicable to teaching content reading in the elementary school; the objectives and the course content provided clarity. In addition, the results obtained on item 4 indicate that the field-centered group thought the content reading course would be useful for a beginning teacher. Item 5 suggests the teaching

TABLE 2

COMPARISON OF MEAN ATTITUDE OF CAMPUS-CENTERED AND FIELD-CENTERED CONTENT READING METHODS GROUPS

Item	Campus-Centered Mean (N=13)	Field-Centered Mean (N=23)	Probability
1. To me the objectives of the course were clearly stated.	2.00	1.26	.00*
2. To me the content of the course was adequate.	1.92	1.35	.01*
3. To me the clarity and purpose of the assignments in the course were reasonable.	1.92	1.44	.06
4. Overall, the course will be useful to me as a beginning teacher.	1.75	1.22	.02*
5. The teaching techniques used in the course were similar to other courses I have taken at this University.	2.25	3.00	.02*
6. I felt free to express my opinion in the course.	1.67	1.26	.03*
7. The instructor demonstrated concern for the quality of teaching.	1.33	1.22	.52
8. The instructor related this course to other fields of study.	2.08	1.87	.64
9. The instructor encouraged students to think independently.	1.33	1.30	.86
10. The intellectual demands of this course were more than those of most undergraduate courses.	2.67	2.22	.11

* Significant at .05 level.

strategies in the field-centered content reading methods course were dissimilar to those in other university courses. Although not statistically significant, further analysis of the data on items 3 and 10 revealed a positive attitude toward the field-centered content reading course.

There was no difference between the control and the experimental group on items 7, 8, and 9. Basically, both groups were taught by the same instructor. The same basic textbook, *Teaching Reading in Content Areas* by Harold Herber, was used by the experimental and control group in content reading methods. All subjects completed the same basic requirements. In addition, the experimental group completed the field experiences.

The field-centered science methods group means for the six RAP items related to the field experiences are presented in Table

3. The results presented in Table 3 suggest that the science methods students have a positive attitude toward the field experiences in a field-centered science methods course. The group responses to items 13 and 14 indicate that the field-centered group tend to feel that the three different field experiences were invaluable in developing their teaching competencies. The responses to item 15 suggest that the preservice teachers thought the different field experiences were extremely beneficial and should be incorporated into the elementary teacher preparatory program.

TABLE 3

MEAN ATTITUDES TOWARD FIELD EXPERIENCES OF FIELD-CENTERED SCIENCE METHODS GROUP

	Item	Mean (N=26)
11.	There was sufficient independence in the designated field experiences.	1.69
12.	There was sufficient structure in the field experience of this course.	2.23
13.	The field experiences in the course were generally appropriate for my program of study.	1.36
14.	The field experiences in the course have enhanced my professional growth.	1.27
15.	I would recommend the field experiences in the course be used again.	1.23
16.	I would recommend the schools for the field experiences in the course be used again.	2.12

Further inspection of the means (Table 3) indicates that the overall attitude toward the field experiences tends to be strongly positive. The two exceptions were items 12 and 16. The responses to items 12 and 16 suggest that more structure should be incorporated into the field experiences.

The field-centered content reading methods group means for the six RAP items related to the field experiences are presented in Table 4. The findings in Table 4 indicate that the content reading subjects have a positive attitude toward the field experiences in the field-centered content reading methods course. The group responses to items 13 and 14 suggest that the field experiences in three different elementary school environments contributed to positive competence in teaching content reading. This may be the result of being highly motivated in relating teaching responsibilities to actual classroom activities. The experimental subjects were directly responsible for pupil learning and may have felt a need to be better prepared and organized in teaching content reading. The overall attitude toward the field experiences tends to be highly positive as shown by the mean in item 15. Items 12 and 16 were exceptions.

TABLE 4

MEAN ATTITUDES TOWARD FIELD EXPERIENCES OF FIELD-CENTERED CONTENT READING METHODS GROUP

Item	Mean (N=28)
11. There was sufficient independence in the designated field experiences.	1.68
12. There was sufficient structure in the field experiences of this course.	2.32
13. The field experiences in the course were generally appropriate for my program of study.	1.57
14. The field experiences in the course have enhanced my professional growth.	1.32
15. I would recommend the field experiences in the course be used again.	1.29
16. I would recommend the schools for the field experiences in the course be used again.	2.07

Although involvement in actual classroom teaching of content reading was deemed essential by the experimental subjects, these field experiences should be more structured and organized as shown in items 12 and 16. This need may have resulted from the ineffective transfer of developmental reading skills to content material.

Summary and Conclusions

The results of this study tend to support the conclusion that involvement in field experiences leads to more positive attitudes toward methods courses. Hence, the evidence suggests that one can improve elementary preservice teachers' attitudes toward methods courses by incorporating field-experiences into preservice methods programs.

Judging from the evidence produced in this study preservice elementary teachers should be involved in a variety of different elementary classroom situations. Through involvement in a variety of classroom situations, preservice elementary teachers will gain the experiences and develop the skills that are needed to teach in the different types of elementary schools.

The research on the field-centered preservice methods courses raises other important research questions. Does the change in attitude toward elementary methods courses occur early or late in the preparatory program? Who are the successful preservice teachers of science and content reading? What are the differences in attitude toward teaching between the field-centered and campus-centered methods courses?

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VI

THE EFFECT OF A FIELD-BASED ELEMENTARY SCIENCE TEACHER EDUCATION PROGRAM ON UNDERGRADUATES' ATTITUDES TOWARD SCIENCE AND SCIENCE TEACHING

JEROME E. DeBRUIN

A current trend in a number of teacher education institutions is to provide early and varied field-based experiences for undergraduate teacher education students. It has been purported by some that prospective teachers need field-based experiences before entering student teaching. What effect does this extensive field-based experience have on prospective teachers' attitudes toward science and science teaching? Do field-based factors account for significant changes in preservice teacher attitudes?

The Study

The central thesis of this study is concerned with providing early field-based experiences and studying their effects on preservice elementary education students' attitudes toward science and science teaching. It is felt that the process undergraduates go through in solving field-based teaching problems and the degree to which they experience success in solving these problems often affects prospective teachers' attitudes toward science and science teaching. It is also felt that if undergraduates experience success in early field-based teaching situations, they may develop a more positive attitude toward science and science teaching. The converse may also be true. If undergraduates do not experience success in field-based teaching they may develop negative attitudes toward science and science teaching.

The University of Toledo's field-based elementary undergraduate program includes field experience for students in three phases: preprofessional career decisions program, junior-senior professional program which includes elementary science methods, and student teaching. Prospective elementary education teachers enter the professional sequence at the beginning of their junior year. They experience science methods in the third quarter of the four-quarter sequence. Students spend five weeks planning for science teaching, four weeks implementing various science lessons in the field, and one synthesis week upon their return to campus.

During the planning phase of instruction and prior to the implementation of instruction a 70-item science attitude inventory, entitled "What Is Your Attitude Toward Science and Science Teaching" by Richard W. Moore 1970, is administered to the undergraduate students in the class. This inventory is also given

at the conclusion of the quarter to note any change in attitude toward science and science teaching. We have recently completed the third successive quarter of collecting and analyzing data via the use of this instrument.

When organizing for teaching, a student must be cognizant of working space and how to effectively use such space. Working in teams of two, students often are assigned small groups of children in small rooms. There is a tendency to separate prospective teachers from classroom teachers when using this practice. Opportunities for feedback are non-existent and further development of positive science attitudes may be hampered. Through constant communication between prospective teachers, classroom teachers, and the facilitator, arrangements can usually be made to have students remain in the actual classroom for their instruction.

Selecting appropriate numbers of children to work with may affect science attitudes. A class of 30 children for a team of 2 is considered an appropriate class size. Students learn quickly that the task of setting up and managing learning centers for a group larger than 30 is difficult. They tend to become frustrated and a negative attitude toward science and science teaching may result from such experience.

Planning an appropriate length of time for instruction may also affect attitudes toward science and science teaching. Some classroom teachers are very generous with their time; others give only the last few minutes of the school day. Thus, prospective teachers sometimes feel slighted and this practice may affect their attitude.

Planning for a variety of teaching situations may affect attitude. Experience should be planned for individual, small, and large groups of children in a number of science areas. Experience with a wide range of children from differing age levels and cultural backgrounds is also viewed by some prospective teachers as having a positive effect on their attitude toward science and science teaching.

Constant on-going longitudinal research should be conducted to evaluate a field-based program and to assess changes in preservice teachers' attitudes toward science and science teaching as a result of such field experience. The assessment instrument used in this study was a 70-item attitude inventory entitled "What Is Your Attitude Toward Science and Science Teaching?" by Richard W. Moore. The instrument contains seven positive and seven negative attitude scales and attempts to determine a prospective teacher's attitude toward science and science teaching. The Moore attitude inventory was used as a pre-post test instrument and was administered prior to and upon completion of the elementary science methods component of the undergraduate program.

Findings

Student responses for pretest and posttest in the Fall, Winter, and Spring quarters of the 1975-76 school year were tabulated. The following tables represent initial analyses of data collected during this period. Table I shows the number and percent of students in

TABLE 1

SCIENCE ATTITUDE CHANGE 1975-76

	Fall 1975		Winter 1976		Spring 1976	
Attitude	Number	Percent	Number	Percent	Number	Percent
Positive Change	27	56	14	54	35	60
No Change	3	6	2	8	4	7
Negative Change	18	38	10	38	19	33
	N=48	100	N=26	100	N=58	100

each quarter whose attitude toward *science* changed either positively, negatively, or remained the same. Table II represents the

TABLE 2

SCIENCE TEACHING ATTITUDE CHANGE 1975-76

	Fall 1975		Winter 1976		Spring 1976	
Attitude	Number	Percent	Number	Percent	Number	Percent
Positive Change	41	85	20	77	48	83
No Change	0	0	3	11.5	2	3
Negative Change	7	15	3	11.5	8	14
	N=48	100	N=26	100.0	N=58	100

number and percent of students whose attitude toward *science teaching* changed either positively, negatively, or remained the same.

It may be noted that there were more positive attitude changes toward science and science teaching during each of the three quarters than negative changes. Positive attitude changes toward science teaching were more prevalent than positive attitude changes toward science. In each quarter, over three-fourths of the subjects reflected positive changes in attitude toward science teaching, and over one-half reflected positive attitude changes toward science. An attempt is now being made to identify and quantify specific factors that may account for the greater number and change in undergraduates' attitude toward science teaching than toward science.

After the above raw data were collected and analyzed, an SPSS program was developed and used as a vehicle for further analyses. Fourteen variables including measures of pre and post attitudes of both science and science teaching and a sum total

identified as a universe total were generated. Pre and post differences in positive and negative attitudes toward science and science teaching were also found. A total of 17 variables were generated. A correlated t-test between differences in means was calculated. Tables 3, 4, and 5 show results for Fall, Winter and Spring quarters of 1975-76, respectively.

As noted in Tables 3, 4, and 5, the mean scores from pretest to posttest for attitude toward science and attitude toward science teaching increased for each of the three quarters. In each case, the mean difference was greater from pretest to posttest. Mean differences were also greater for attitude toward science teaching than

TABLE 3

CORRELATED t-TEST BETWEEN DIFFERENCES IN MEANS–
FALL 1975

Variable	N	Mean	S.D.	Diff Mean	r	t-value	df	2-Tail Prob
Total Attitude Science Pre	48	82.7083	8.666	2.0104	0.80	2.50	47	P<.016
Total Attitude Science Post	48	84.7188	8.948					
Total Attitude Teaching Pre	48	54.4583	7.740	7.3021	0.63	7.59	47	P<.001
Total Attitude Teaching Post	48	61.7604	7.797					
Universe Total Pre	48	137.1667	14.573	9.3125	0.75	6.26	47	P<.001
Universe Total Post	48	146.4792	14.327					

TABLE 4

CORRELATED t-TEST BETWEEN DIFFERENCES IN MEANS–
WINTER 1976

Variable	N	Mean	S.D.	Diff Mean	r	t-value	df	2-Tail Prob
Total Attitude Science Pre	26	83.6538	7.402	2.807	0.73	2.45	25	P<.022
Total Attitude Science Post	26	86.4615	8.353					
Total Attitude Teaching Pre	26	55.7308	5.738	6.3846	0.29	3.90	25	P<.001
Total Attitude Teaching Post	26	62.1154	7.936					
Universe Total Pre	26	139.3846	10.076	9.1923	0.60	4-16	25	P<.001
Universe Total Post	26	148.5769	13.966					

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TABLE 5

CORRELATED t-TEST BETWEEN DIFFERENCES IN MEANS–
SPRING 1976

Variable	N*	Mean	S.D.	Diff Mean	r	t-value	df	2-Tail Prob
Total Attitude Science Pre	58	80.1983	6.989	2.3534	0.60	2.77	57	P<.008
Total Attitude Science Post	58	82.5517	7.479					
Total Attitude Teaching Pre	58	52.2500	8.188	6.5603	0.54	6.11	57	P<.001
Total Attitude Teaching Post	58	58.8103	8.766					
Universe Total Pre	58	132.4483	13.646	8.9138	0.59	5.33	57	P<.001
Universe Total Post	58	141.3621	14.470					

attitude toward science. Mean differences for pretest-posttest attitudes toward science teaching ranged from 6.3846 to 7.3021 and 2.0104 to 2.8077 for science.

In an effort to determine correlations between pretest-posttest attitude change toward science and science teaching, a Pearson Correlation Coefficient was determined. These correlations for pre and post science teaching attitude change ranged from .290 to .632 and from .602 to .800 for science. This would seem to indicate a greater change in attitude toward science teaching than science. When analyzing change in attitude in terms of standard deviations, it can be noted that there also seemed to be a greater change in attitude toward science teaching than toward science.

It should be emphasized that the results of this year-long study were consistent over three consecutive quarters with different groups of students. In all cases, an increase in student attitude toward science and science teaching was observed.

Numerous possibilities for future research are being studied. Primary research efforts will focus on the identification of field-based factors and isolating these factors from factors evident on campus. To accomplish this task, the attitude inventory will be administered prior to and immediately following field experience. It is hoped that this procedure will tend to further isolate field-based variables from on-campus variables. Once field-based variables are identified and isolated, additional factors and the frequency of these factors will be noted for further study. Tape recordings of seminar debriefing sessions may also expedite this study.

A number of other possibilities for future research are being pursued. An effort is being made to determine whether under-

graduates who have a positive attitude toward science also have a positive attitude toward science teaching and vice versa. Factor analyses of test items and scale items in the Moore attitude inventory are being carried out.

Additional research studies are being planned for the study of isolated field-based factors that directly influence prospective teachers' attitudes toward science and science teaching. Studies dealing with the ratio of teacher talk to student talk, question asking, question hierarchies, wait time, and value laden activities are being examined but are only in an infant stage at this writing. The effects of preservice teachers on the classroom teacher's attitude toward science and science teaching are also being studied. Administering the 70-item attitude inventory to classroom teachers prior to the placement of preservice teachers is also being considered. Refinement of instruments used in noting changes in children's attitudes toward science is being done.

In the end, it is believed that the process that undergraduates go through in solving field-based teaching problems and the degree to which they experience success in solving problems often affects prospective teachers' attitudes toward science and science teaching. A cooperative relationship based on mutual trust and respect may enhance the study of attitude change. Constant communication leads to mutual understandings. Mutual understandings lead to professional and personal growth for all concerned.

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VII

AN ANALYSIS OF THE RELATIONSHIP OF PRESERVICE ELEMENTARY TEACHERS' ATTITUDES TOWARD TEACHING SCIENCE AND THEIR SCIENCE TEACHING PLANNING PRACTICES

HAROLD H. JAUS

Many educators believe the development of science process skills in children to be a major objective of education (Gagne, 1965, pp. 1-8; Herron, 1970; Okey, 1972). In recent years there has been more emphasis on elementary school children learning science process skills than on their learning science content. Indeed, many authors have noted that the intent of the new elementary science curricula and science textbooks has been to shift the emphasis to include the teaching of science process skills (Esler, 1973, pp. 10-35; Goodlad, 1966, pp. 20-35). According to Rowe (1973) there are at least 25 elementary science textbook and curricular programs available. In analyzing these programs, she found science process skill development was a major common factor (p. 6-52).

It appears, then, that the science materials available for elementary school children stress the teaching of science process skills in some form. This approach, however, brings up an important question. Is there a relationship between an elementary teacher's attitude about teaching science as a process and his subsequent science teaching planning practices? In other words, does an elementary teacher with positive attitudes toward teaching the science process skills plan for science activities that teach these skills to children?

The Study

The primary purpose of this investigation was to determine the relationship of preservice elementary teachers' attitudes toward teaching science as a process and their subsequent science process skill planning practices. Sixty junior year preservice elementary teachers enrolled in a science methods course were involved in the study. All subjects were provided instruction in the integrated science process skills via 10 self-instructional pamphlets. Upon completion of the pamphlets, the subjects were administered an integrated science process skills achievement test. All subjects achieved the 90 percent criterion established for this test.

Following the test, the subjects were administered a science process skill attitude measure which was developed by the investigator. This measure contained 30 statements to which the subjects responded on a Likert-type scale consisting of five categories rang-

ing from strongly agree to strongly disagree. The reliability of this instrument was determined by the test-retest method. For this purpose 30 subjects not involved in the study were tested and retested 4 days later. A Pearson product-moment correlation coefficient of 0.90 was obtained.

In scoring this measure, those statements that were judged indicative of a positive attitude were given a score of 5 for a strongly agree response, progressing downward to score of 1 for a strongly disagree response. For example, regarding the statement, "Children will have a better understanding of science if they are taught how to conduct experiments," a strongly agree response was scored a 5; a strongly disagree response was given a score of 1. On the other hand, if a strongly disagree response indicated a positive attitude, then the scoring procedure was reversed. An example of a statement scored in this manner was "I am more interested in the number of science facts and concepts a child remembers than in how well he solves science problems."

Four days after completion of the attitude measure, the subjects were administered a questionnaire. This instrument contained 10 integrated science process skill objectives and 10 science content objectives. These objectives were randomly ordered on the questionnaire. The subjects were to select any 10 objectives they felt should be included in planning.

It was assumed that these subjects who selected the integrated science process objectives from the questionnaire were demonstrating planning practices indicative of teaching science as a process. On the other hand, subjects who selected content objectives were not demonstrating planning practices indicative of teaching science as a process.

As a further measure of planning practices, each subject prepared and handed in a set of lesson plans. The investigator evaluated the submitted lesson plans by counting the number of integrated science process skill objectives written by each subject. The investigator also counted the number of written learning activities dealing with integrated science process skill learning experiences. For example, a learning activity requiring a child to read a paragraph in an elementary science textbook was not considered an integrated science process skill learning experience. On the other hand, a learning activity requiring a child to construct a graph was judged to be an integrated science process skill learning experience.

Findings

The relationships between the integrated science process skill attitude measure scores, the scores obtained on the objectives questionnaire, and the number of integrated science process objec-

tives and learning activities written in lesson plans were examined by calculating Pearson product-moment correlations.

Significant correlation coefficients ($p<.01$) were obtained on the relationships between the measures used in this investigation. It was found that subjects who scored high on the attitude measure also selected more integrated science process skill objectives from the questionnaire ($r=.58$). Subjects who scored high on the attitude measure wrote more integrated science process skill objectives in their lesson plans ($r=.62$). These same subjects wrote more integrated science process skill learning activities ($r=.71$).

Conclusions

The results of this study indicated that prospective elementary teachers who exhibit positive attitudes toward the use of the integrated science process skills select and prepare materials that provide for integrated science process skill instruction in the classroom. In this case, at least, possessing a positive attitude about an instructional method does mean that such a method is overtly practiced.

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VIII

AN INVESTIGATION OF THE SCIENCE BACKGROUND OF ELEMENTARY TEACHERS

KENNETH D. MOORE

Maben (1973), after surveying 1266 elementary schools in the Far West and Great Lakes Regions of the United States, reports, "Significantly, over two-thirds of both regions felt that both lack of science knowledge and science methods were barriers to effective science teaching." Maben further comments, "These findings do not demonstrate a major change from findings by previous investigators . . ." Maben's findings suggest that elementary teachers' science knowledge and science methodology knowledge need to be upgraded.

The Study

This study was undertaken to determine the status of science teaching in the elementary schools and the present science content and science methods needs of elementary teachers. In addition, the study was designed to assess the recency of training of the sample elementary teachers.

Two-hundred sixty elementary teachers were selected at random from the 6,185 elementary teachers employed in the 21 school districts of Harris County, Texas, to be surveyed. The Harris County school districts were considered as being a highly desirable setting for a study of this nature since the region represents a wide cross-section of the different socioeconomic levels. In addition, the region offered the added advantage of being composed of a multicultural population.

The elementary teachers in the selected sample were asked to supply information regarding (1) the amount of science they taught, (2) the year of their last science methodology course, (3) the year of their last science content course, and (4) the content area of their last science content course. Of the 260 questionnaires distributed, returns were received from 127 teachers (48.9 percent).

Because it was thought that there would exist an observable difference in the amount of science being taught at the different elementary grade levels and by teachers with different numbers of years teaching experience, each respondent was also asked to indicate the grade level taught and the number of years of teaching experience.

Findings

Science Taught

The teachers' responses categorized by grade level and the amount of science taught are presented in Table 1. The response choices available were None, Some, and a Great Deal. An inspection of the data shows that the lower grade level teachers (K-2) in the sample taught less science than did the higher grade level teachers (3-6). This becomes quite apparent when the category None is examined across the category Grade Level. About 20 percent of the teachers at each of the lower grades stated that they taught no science whereas less than 10 percent (zero percent for grades five and six) of the teachers at the higher grades indicated that they taught no science. These findings suggest that more emphasis should be placed on eliminating the science needs of elementary teachers at the lower elementary grades (K-2).

TABLE 1

PERCENT OF TEACHERS BY GRADE LEVEL CHOOSING EACH RESPONSE CATEGORY REGARDING SCIENCE TAUGHT

	Grade Level							
Science Taught	Kindergarten (N=15)	First Grade (N=17)	Second Grade (N=15)	Third Grade (N=25)	Fourth Grade (N=22)	Fifth Grade (N=20)	Sixth Grade (N=13)	Total (N=127)
None	33.3	17.6	20.0	8.0	9.1	0.0	0.0	11.8
Some	53.3	70.6	66.7	72.0	45.5	45.0	15.4	54.3
Great Deal	13.3	11.8	13.3	20.0	45.5	55.0	84.6	33.9

The teachers' responses categorized by experience and the amount of science taught are presented in Table 2. The data show that teachers in the sample with four or more years of experience taught more science than did the teachers with less than four years experience. An examination of the category Great Deal across the category Experience points out this difference. Only 10 percent of the teachers with less than four years experience indicated that they taught a great deal of science whereas almost 40 percent of the teachers with four or more years experience stated that they taught a great deal of science. This difference may be due, in part, to the sharp decline in science interest over the last few years. On the other hand, it is possible that science methods courses in the colleges and universities are not preparing preservice elementary teachers for science teaching in the elementary schools.

TABLE 2

PERCENT OF TEACHERS BY EXPERIENCE CHOOSING EACH RESPONSE CATEGORY REGARDING SCIENCE TAUGHT

Science Taught	Years Experience 1-3 (N=20)	4-9 (N=51)	10+ (N=56)
None	10.0	11.8	12.5
Some	80.0	51.0	48.2
Great Deal	10.0	37.3	39.3

Science Content and Methodology

The years recorded by the teachers in the sample for their last science content course and methodology course are summarized in Table 3. Approximately 5 percent of the teachers indicated that they had had no science methodology course. If one also assumes that those teachers who did not respond to the question have not had a science methodology course, this percentage increases to almost 20 percent.

Over 5 percent of the teachers in the sample reported that they had not had a science content course. Unfortunately, 15 percent of the teachers did not respond to the question. It may be that the teachers who did not respond also had not had a science content course. If one makes such an assumption, the percentage reporting no science content course is over 20 percent.

The percentages of teachers reporting their last science methodology course and their last science content course before 1960 were 11 and 19.7, respectively. Further examination of Table 3 reveals that 20 percent of the teachers had their last science methodology course more than 10 years ago, and almost one-third of the teachers had their last science content course over 10 years ago. This suggests that many elementary teachers are using outdated methods in the teaching of science. In addition, it indicates that many of the teachers in the sample are badly in need of updating in science content.

TABLE 3

PERCENT OF TEACHERS INDICATING VARIOUS YEARS OF LAST SCIENCE METHODOLOGY AND CONTENT COURSE

Course	Before 1960	1960-64	1965-69	1970-74	None	No Response
Methodology (N=127)	11.0	8.7	28.3	33.9	4.7	13.4
Content (N=127)	19.7	11.8	22.8	25.2	5.5	15.0

Area of Science Content

The science areas of the teachers' last science content courses are given in Table 4. Almost one-third of the teachers indicated that their last science content course was a course in one of the biological sciences. Very few teachers, approximately 9 percent, indicated that their last content course was in physical or earth science. Apparently, when teachers update their science content they do so in one of the biological sciences.

Approximately 8 percent of the teachers reported that their last content course was in general science and 13.4 percent reported their last content course was in elementary science. It may be that the teachers in these groups considered their science methods course a content course. Unfortunately, there is no way to be sure of the content of these two courses. In addition, about 24 percent of the teachers did not respond to the question. This group most likely consists of teachers who had no content course and teachers who could not remember the content of their last science course.

TABLE 4

PERCENT OF TEACHERS INDICATING VARIOUS SCIENCE CONTENT AREAS FOR LAST SCIENCE COURSE

Content Area	Percent (N=127)
General Sciences	7.9
Elementary Science	13.4
Biological Science	31.5
Physical Science	9.4
Earth Science	8.7
None	5.5
No Response	23.6

Summary and Conclusions

The findings in this study seem to agree with the findings reported by Maben (1973) and other investigators that elementary teachers lack preparation in science content and science methodology. Apparently some institutions do not require preservice teachers to have training in science methodology and science content. However, if there is to be an upgrading in elementary science teaching, elementary teachers should be provided with a general background in science content and an understanding of how to use the subject matter effectively in teaching children. Elementary teachers should not become specialists in any area of science, but they should have a general grasp of the biological, physical, and earth sciences.

The findings also suggest that periodic updating of experi-

enced elementary teachers in science content and science teaching methods is needed. Science content courses and science methodology courses for elementary teachers should be developed at the graduate level so that career teachers can periodically update their science content and science teaching methods. In addition, school districts should provide an incentive to elementary teachers so that they acquire periodic science updating.

This study has pointed out some of the apparent science needs of elementary teachers that should be alleviated if there is to be an improvement in elementary science teaching. Barretto (1969) reported that preservice teachers with the greater number of semester hours in science had more positive attitudes toward science than those with fewer hours. Additional research may reveal the same for inservice teachers.

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IX

A SCIENCE NEEDS ASSESSMENT OF ELEMENTARY TEACHERS

KENNETH D. MOORE

It is generally acknowledged that the role of the elementary science teacher has changed due to changes in elementary science curricula, materials, and media (Hurd, 1969). As a result of this change in role, elementary teachers have faced the realization that they have needs which limit their effectiveness as science teachers. The development of procedures for identifying and categorizing these needs has been a major concern of educational research for numerous years.

Generally, researchers (Blackwood, 1965; Maben, 1973; Piltz, 1954; and Savage, 1968) have relied on questionnaires to obtain data pertaining to elementary teacher needs. After identifying specific elementary teacher needs, most researchers have attempted to categorize these needs according to common unifying themes. The data obtained through the distribution of these questionnaires are then utilized in the development and coordination of preservice and inservice training programs.

Even when the science needs of elementary teachers are identified, many times inservice programs are designed to alleviate these identified needs without regard for the degree of intensity of the identified needs. The disregard for intensity of need too often results in emphasis being placed on the low intensity needs of elementary teachers. Inservice programs, therefore, often are doomed to failure due to improper evaluation of the high intensity needs of the participating teachers.

Too often inservice programs are designed without differentiation as to the particular needs of the teachers for whom they are designed. Individual teacher grade level and previous teaching experience differences are often ignored. The importance of determining the effect of various teacher related characteristics upon identified teacher needs is pointed out by Smith, Otto, and Harty (1970) in their research study with a selected group of elementary teachers. They comment:

> In-service programs are often differentiated only for secondary and elementary teachers. Apparently there is need to differentiate within the elementary ranks as well. In-service programs which assume common needs for all elementary teachers may in fact be irrelevant to the greatest concerns of the teachers to whom they are offered. (p. 448)

This statement implies that, before setting up any inservice program, research should be carried out to determine which needs are shared by all elementary teachers. In addition, research should be undertaken to determine the effect of various elementary teacher characteristics on identified needs.

The Study

The purposes of this study were four-fold: 1) to explore the utility of the factor analytic procedure as a means of identifying the science needs of elementary teachers; 2) to determine the degree of intensity of the identified science needs of elementary teachers; 3) to determine the relationship between teacher grade level and the identified science needs of elementary teachers; and 4) to determine the relationship between teacher experience and the identified science needs of elementary teachers. More specifically, the questions to be answered were:

1. Is the factor analytic procedure an effective means of identifying the science needs of elementary teachers?
2. Is there a difference in the degree of intensity of identified science needs of elementary teachers?
3. How similar are the identified science needs of elementary teachers at the different grade levels?
4. Are the identified science needs of elementary teachers related to the number of years service?

The subjects of this study were 200 elementary teachers from the 21 school districts of Harris County, Texas. Randomization was accomplished by selecting the elementary teachers from a listing of all elementary teachers employed in Harris County during the 1974-75 academic school year.

The *Moore Assessment Profile* (MAP) (Moore, 1976) was the instrument used to collect the data for this study. The MAP consists of a list of 117 validated need statements which were designed to tap a wide range of science teacher needs. The reliability of the MAP by Hoyt's analysis of variance method is .986. Following each need statement, there are columns used to form a continuum of from 1 to 4 by which the respondent can indicate whether that statement is perceived as an area of no need, little need, moderate need, or much need, respectively.

The MAP was mailed to the randomly selected elementary teachers in the Spring of 1975. A general information sheet was included as part of the MAP cover sheet in order to obtain information with regard to the sample distribution. Returns were received from 107 teachers which represented 53.5 percent of the

random sample. An analysis of the returns with regard to distribution within the sample is presented in Table 1.

An examination of Table 1 reveals that the sample returns consisted of a fairly uniform sampling of elementary grade level

TABLE 1

GRADE LEVEL BY EXPERIENCE DISTRIBUTION OF SAMPLE

Grade Level	Experience							
	Less Than Four Years (N=15)	%	Four to Nine Years (N=42)	%	More Than Nine Years (N=50)	%	TOTAL (N=107)	%
Kindergarten	4	26.7	2	4.8	6	12.0	12	11.2
First	0	0.0	9	21.4	9	18.0	18	16.8
Second	1	6.7	6	14.3	5	10.0	12	11.2
Third	3	20.0	9	21.4	9	18.0	21	19.6
Fourth	3	20.0	6	14.3	6	12.0	15	14.0
Fifth	2	13.3	7	16.7	8	16.0	17	15.9
Sixth	2	13.3	3	7.1	7	14.0	12	11.2

and experience. Although one void and several near voids were present, it was felt that they did not constitute a serious limitation to the representativeness of the sample since there should exist much overlap in the science needs of elementary teachers. It was therefore concluded that the sample returns were fairly representative of elementary teachers.

The teacher responses to the need statements on the MAP were assigned a weighted value, 1 through 4, which corresponded to the columns on the assessment profile. The resultant weighted responses were submitted to factor analysis utilizing principal components factor extraction and orthogonal rotation by the Varimax criterion.

Once identified, the teacher responses to those items loading over 0.500 on each of the identified factor needs were analyzed. The teacher mean factor scores for the identified factors were calculated in order to test for a difference in the degree of intensity of need of the identified factor needs. The effect of teacher grade level and teacher experience on the identified factor needs were tested by means of one-way analyses of variance.

Findings

The factor analysis resulted in the identification of 24 factors which, together, accounted for 83.6 percent of the total variance on the MAP. An analysis of the high loading items on each of the 24 factors was undertaken in order to determine which factors were interpretable. Ninety-three of the 117 items on the MAP loaded over 0.500 on the extracted factors, with 13 of the 24 factors having 3 or more items that loaded over 0.500.

The 13 factors with 3 or more items loading over 0.500 were retained for interpretation. These 13 factors, together, accounted for 63.2 percent of the total variance on the MAP. An analysis of each of the 13 factors' cluster of high loading items resulted in factor names which best conceptualized each factor's high loading items. The resultant 13 factor names were:

Factor	I	Teaching the basic scientific fundamentals.
Factor	II	Updating in science and science related topics.
Factor	III	Establishing and maintaining class control.
Factor	IV	Evaluating and reporting student progress.
Factor	V	Developing a greater understanding of human behavior.
Factor	VI	Understanding the dialects of the culturally different.
Factor	VII	Developing an understanding of the relationship between science and society.
Factor	VIII	Determining and assuming science teaching responsibilities.
Factor	IX	Providing realistic science experiences.
Factor	X	Additional courses in the history of science and the philosophy and history of education.
Factor	XI	Utilizing audio-visual materials and library facilities.
Factor	XII	Developing confidence in working with experimental materials.
Factor	XIII	Training in science teaching methodology.

The means and rankings of the teacher sample responses to the high loading (over 0.500) items on each of the 13 identified science factor needs are presented in Table 2. An examination of Table 2 shows that there is indeed a difference in the degree of intensity of need of the identified science factor needs. In terms of the weighted value given the teacher responses, it appears that the teacher sample had more than moderate need on four of the identified factor needs. The identified factor needs, ranked from most intense to least intense, which were perceived as being more than moderately needed were Factor IX Providing realistic science experiences, Factor I Teaching the basic scientific fundamentals, Factor VII Developing an understanding of the relationship between science and society, and Factor XIII Training in science teaching methodology.

TABLE 2

MEANS AND RANKINGS OF TEACHER SAMPLE ON FACTOR NEEDS

	Factor Need	Mean	Rank
I	Teaching the basic scientific fundamentals	3.20	2
II	Updating in science and science related topics	2.81	9
III	Establishing and maintaining class control	2.93	5
IV	Evaluating and reporting student progress	2.45	11
V	Developing a greater understanding of human behavior	2.80	10
VI	Understanding the dialects of the culturally different	2.37	12
VII	Developing an understanding of the relationship between science and society	3.15	3
VIII	Determining and assuming science teaching responsibilities	2.91	7
IX	Providing realistic science experiences	3.25	1
X	Additional courses in the history of science and the philosophy and history of education	1.94	13
XI	Utilizing audio-visual materials and library facilities	2.92	6
XII	Developing confidence in working with experimental materials	2.86	8
XIII	Training in science teaching methodology	3.05	4

The data presented in Table 3 indicate there are no significant differences in the degree of intensity of the identified science factor needs between grade levels. Although the differences in factor means were not significant, an inspection of the factor means indicates that primary (first, second, and third grade) teachers, in general, had the highest degree of intensity of need in the 13 identified science factor need areas.

Further inspection of Table 3 reveals that, in addition to a more than moderate need for help with Factor I, VII, IX, and XIII, the primary teachers had more than a moderate need for help with Factor III Establishing and maintaining class control, Factor VIII Determining and assuming science teaching responsibilities, Factor XI Utilizing audio-visual materials and library facilities, and Factor XII Developing confidence in working with experimental materials. These additional needs suggest that primary teachers are unsure as to the amount of science they should be teaching. Additionally, it seems to indicate that primary teachers fear the teaching of science.

It should also be noted that kindergarten teachers did not perceive a high intensity need for help with Factor I Teaching the

TABLE 3

MEANS AND SIGNIFICANCE LEVELS FOR VARIABLE GRADE LEVEL

	Mean							
Factor Need	Kindergarten (N=12)	First Grade (N=18)	Second Grade (N=12)	Third Grade (N=21)	Fourth Grade (N=15)	Fifth Grade (N=16)	Sixth Grade (N=13)	Significance Level
I	2.86	3.40	3.43	3.40	3.03	3.21	2.92	.088
II	2.57	2.83	2.96	2.74	2.62	3.03	2.89	.822
III	2.91	3.25	3.12	3.05	2.49	2.79	2.84	.340
IV	2.21	2.62	2.56	2.63	2.39	2.17	2.41	.440
V	2.65	2.99	3.25	2.70	2.77	2.56	2.74	.476
VI	2.39	2.81	2.61	2.27	2.42	1.94	2.18	.244
VII	3.06	3.42	3.33	3.05	3.13	3.00	3.08	.700
VIII	2.81	3.06	3.19	2.94	2.71	2.75	2.92	.701
IX	3.25	3.41	3.44	3.30	3.42	3.02	2.85	.381
X	1.97	2.22	2.31	1.94	1.78	1.79	1.54	.281
XI	2.64	3.17	3.03	3.24	2.62	2.75	2.74	.367
XII	2.58	3.11	3.06	3.06	2.93	2.42	2.69	.203
XIII	2.69	3.46	3.14	3.17	2.98	2.85	2.82	.259

basic scientific fundamentals and Factor XIII Training in science teaching methodology, whereas the other grade level teachers felt a high intensity need in these two areas. This difference may be due to the feeling, on the part of kindergarten teachers, that science is a subject that should not be taught to kindergarten children.

The results presented in Table 4 indicate that there is no significant relationship between the degree of intensity of the identified science factor needs and the teachers' years of experience. Judging from the evidence, it appears that those teachers with less than four years experience had, in addition to the more than moderate need for help with Factors I, VII, IX, and XIII, more than a moderate need for help with Factor III Establishing and maintaining class control, and Factor VIII Determining and assuming science teaching responsibilities.

Summary and Conclusions

Evidence produced in this study suggests that the factor analysis procedure is quite satisfactory in identifying the science needs of elementary teachers. The procedure offers an approach which should aid researchers in determining the effect of relevant variables on the science needs of elementary teachers.

The evidence also suggests that the science needs of elementary teachers can be categorized into 13 general areas. This investigator, therefore, suggests that elementary preservice and inservice program developers and coordinators direct their attention toward

TABLE 4

MEANS AND SIGNIFICANCE LEVELS FOR VARIABLE EXPERIENCE

Factor Need	Mean: Less Than Four Years (N=15)	Four to Nine Years (N=41)	More Than Nine Years (N=51)	Significance Level
I	3.18	3.29	3.14	.571
II	2.93	2.79	2.79	.853
III	3.04	2.99	2.86	.718
IV	2.48	2.50	2.39	.785
V	2.91	2.93	2.66	.319
VI	2.07	2.41	2.43	.445
VII	3.15	3.27	3.06	.453
VIII	3.02	2.88	2.92	.804
IX	3.16	3.32	3.22	.771
X	1.82	1.98	1.94	.851
XI	2.91	2.85	2.97	.830
XII	2.71	2.86	2.90	.789
XIII	3.20	3.01	3.03	.777

the 13 general areas of science needs identified in this study.

The results of the study indicate that there is a difference in the degree of intensity of the science needs of elementary teachers. The evidence suggests that inservice programs should be developed which place greatest emphasis on alleviating elementary teacher science needs in four general areas. These four areas include Providing realistic science experiences, Teaching the basic scientific fundamentals, Developing an understanding of the relationship between science and society, and Training in science teaching methodology.

Judging from the evidence, primary teachers have, in general, a higher degree of intensity of need for help in the 13 identified need areas, but the differences proved not to be statistically significant. In addition, the study suggests that there exists no significant relationship between the science needs of elementary teachers and the years of teaching experience.

Although the differences were not statistically significant, the primary grade teachers and teachers with less than four years experience indicated a higher degree of intensity of need for help with Establishing and maintaining class control and Determining and assuming science teaching responsibilities than did the other elementary teachers. In addition, the primary grade teachers indicated a higher degree of intensity of need for help with Utilizing audio-visual materials and library facilities and Developing confidence in working with experimental materials than did the other elementary teachers. Apparently, the desire for inservice help with the teaching of science is more intense for primary grade level teachers and for teachers with less than four years of teaching

experience. One possible explanation for these differences is that primary teachers and teachers with less than four years experience are unsure of their science teaching responsibilities in the classroom. It may be that these teachers should be provided information on the need and importance of science teaching in the elementary school.

In general, the evidence produced in this study suggests that inservice programs should be designed to meet identified needs of elementary teachers. In addition, primary grade level teachers and teachers with less than four years experience have unique needs that demand special attention.

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X

INVESTIGATION OF TEACHER BEHAVIOR: INTERACTION WITH NEW CURRICULUM MATERIAL

CARL F. BERGER

During the 1960's and 1970's new curricular materials were published that emphasized "hands-on" activities of children in the classroom. These new materials often required quite differing teacher behaviors on the part of the instructors working with students in the classroom. This chapter outlines six studies to illustrate changes in teacher behavior after having received instruction in teaching new curricular materials emphasizing hands-on activities.

One model for analyzing classroom interaction utilizes the concept of locus of control. Locus of control means the persons or group who determines what occurs next in the classroom; it is the focus for decision making. Three different loci for classroom decision making were used in the first study presented in this chapter. One is referred to as teacher oriented. This means that the teacher or other immediate authority figure, such as a book or film, initiates what will happen next in the classroom. A second locus of control is referred to as student/teacher cooperation. In this locus of control, decisions in the classroom are shared by both the teacher and the students. In one instance, for example, teachers may suggest experiments to do, and students select particular experiments from these options. Conversely, the students could design several experiments, and the teacher would make the decision as to the experiments that will be accomplished. The third locus of control is called student oriented. In this locus of control, students individually or in groups decide what occurs next within the classroom. Particular loci are not usually exclusive; often in a given classroom the locus of control shifts from one decision making pattern to another. It was an assumption that the locus of control patterns for different science programs differed significantly, and the change in teaching behavior could be detected by the change in the pattern of locus of control.

In 1969, 1970, and 1971, teachers were polled to indicate their patterns of locus control in differing science teaching situations. Because direct observation of the large number of teachers involved in the study as they taught was not possible (too expensive and time consuming, plus observer pressure), a secondary technique was derived. A simulation process was used to gather teacher data. In this instance, the simulation utilized a color motion picture film of five teachers using new curriculum materials in a wide variety of student/teacher interactions. At nine points in the film, the pro-

jector was stopped and teachers observing the film were asked to respond to teaching scenes that they had just observed. Their responses were to indicate their degree of agreement or disagreement with six possible decisions of what would occur next in the classroom. Of the six possible responses, two were selected as being representative of each of the three differing locus of control. After each scene, teachers agreed or disagreed with two teacher oriented responses, two student/teacher cooperation responses, and two student oriented responses.

The scenes teachers observed included those of teachers distributing materials, asking students questions, answering student questions, handling students' intellectual disagreements, students working with organisms, teachers introducing concepts, teachers responding to children getting ready to do experiments, and teachers responding to students' ideas. These scenes typify the high student/teacher interaction found in many of the new elementary school science programs. A sample response page is shown in Illustration 1.

Illustration 1

SCENE 2

The boy asked, "What's the black stuff?" You would:

Have him present his question to the class. ____

List a few experiments he could try in order to find out what the "black stuff" is. ____

Tell him of an experiment in which he could find out what the "black stuff" is. ____

Let him select an experiment from a few he found in the book or student manual. ____

Have him ask the other children who were with him at the time of the observation. ____

Tell him the "black stuff" is detritus. ____

4 - agree completely
3 - agree somewhat
2 - neither agree nor disagree
1 - disagree somewhat
0 - disagree completely

In this particular study, teachers using the materials developed by the Science Curriculum Improvement Study (SCIS) were sampled. In later studies of over 1,200 teachers, comparable results were obtained with other curricular programs having characteristics similar to the SCIS approach.

Teachers indicated their degree of agreement or disagreements using a scale of zero to four, with zero being complete disagreement and four being complete agreement. Scores for both responses of each locus of control could be totaled for each scene to give

ANSWER SHEET

TOTALS

☐ A ☐ B ☐ C

Name: _____

Test taken at (city): _____

Date: _____

Sex: Male ☐ Female ☐

Age: 19-30 ☐ 51-60 ☐
31-40 ☐ 61 Over ☐
41-50 ☐

Number of years teaching: _____

Primary (K-3) ☐ Secondary (9-12) ☐
Intermediate (4-8) ☐ College ☐

Are you presently teaching in

An open classroom ☐
A self-contained classroom ☐

At any time in your career have you returned to teaching after being away for several years?

Yes ☐ No ☐

How long an absence? _____ years

Scene 9	Scene 8	Scene 7	Scene 6	Scene 5	Scene 4	Scene 3	Scene 2	Scene 1
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐	☐	☐	☐

Illustration 2

a preference for each of the locus of control patterns for that scene. In addition, totals for each scene could be added to give three grand totals for the nine scenes, indicating the relative proportion of teacher oriented, student/teacher cooperation, and student oriented locus of control. The three grand totals were then used to describe a profile of the teachers' projected behaviors if they were to teach materials similar to those shown in the film. A sample score sheet is shown in Illustration 2.

The film used was the award winning "Don't Tell Me, I'll Find Out." This film showed students and teachers in first through third grade using the Science Curriculum Improvement Study Life Science Materials.

The simulation device (film and response packet) was entitled Decisions in Teaching. Using this device six research studies were done.

1. Were the responses teachers reported congruent with the behaviors they actually used in the classroom?
2. Did education in the programs cause differences in response to "Decisions in Teaching"?
3. Were teachers of new programs self-selective, that is, did teachers starting education or use of new programs differ in their responses to teachers not starting new programs?
4. Could Decisions in Teaching be used to differentiate programs other than SCIS?
5. Did teaching the new program cause changes in the responses teachers made to Decisions in Teaching?
6. Were there differences between teachers and SCIS staff after teachers had taught the program for one or two years?

Study One - Did classroom behaviors correspond to predicted behaviors?

Were the locus of control behaviors that the teachers agreed with in the film indicative of their behaviors as they actually took place in the classroom? To answer this question, a limited sample of teachers was observed for six months. While only 13 teachers took part in this limited study, the high amount of observation decreased observer influence as a possible source of teacher variation. Prior to the year's work, these teachers, all of whom had taught the SCIS program for at least one year, watched the film and responded to the simulation.

Then, 13 teachers were observed by two trained observers at least twice a week when they were teaching science. One hundred fifty-two situations similar to scenes shown in the film were recorded by the observers. Behaviors of the 13 teachers in the

152 situations matched their predicted behaviors in 113 situations. Thus, 74 percent of the predicted behaviors actually occurred in the classroom. The results, divided into locus of control categories, are shown in Table 1.

TABLE 1

RATIOS OF PREDICTED TO OBSERVED BEHAVIORS FOR EACH LOCUS OF CONTROL CATEGORY

Category	Predicted Behavior	Observed Behavior
Teacher Oriented	12	32
Student/Teacher Cooperation Oriented	73	92
Student Oriented	28	28
Total	113	152

A chi square test used to find if the observed versus predicted behaviors was significant yielded a X^2 of 5.66 with two degrees freedom which was less than X^2 at $\alpha = .05$. There was no significant difference between the predictions of teaching behaviors and the observed teaching behaviors.

The film and simulation known as Decisions in Teaching were then utilized to find if changes in teaching behavior as measured by changes in locus of control were found before and during the use of the SCIS materials.

The Decisions in Teaching device was responded to by 184 teachers in varying geographical locations. Groups consisted of 51 teachers with no SCIS experience, 69 teachers with no SCIS experience but beginning SCIS cooperative college school science training programs, and 76 teachers completing such a training program. In addition, the longitudinal study allowed the study of 45 teachers who had taught the SCIS program with training and without training for one and for two years.

General results yielded the following information:

1) Teachers predicted they would agree with far fewer teacher oriented behaviors in the classroom than with student/teacher cooperation and student oriented behaviors. Of the 184 teachers involved, the means and standard deviations were:

Teacher oriented $\bar{x} = 26.78$ S.D. $= 10.18$
Student/teacher cooperation $\bar{x} = 47.26$ S.D. $= 8.70$
Student oriented $\bar{x} = 54.35$ S.D. $= 8.82$;

2) Scene analysis indicated that teachers responded independently to statements using the context of the situation.

3) A three-dimensional scattergram of the scores indicated the possibility of a strong correlation between the three sub-measures; (see illustration 3)

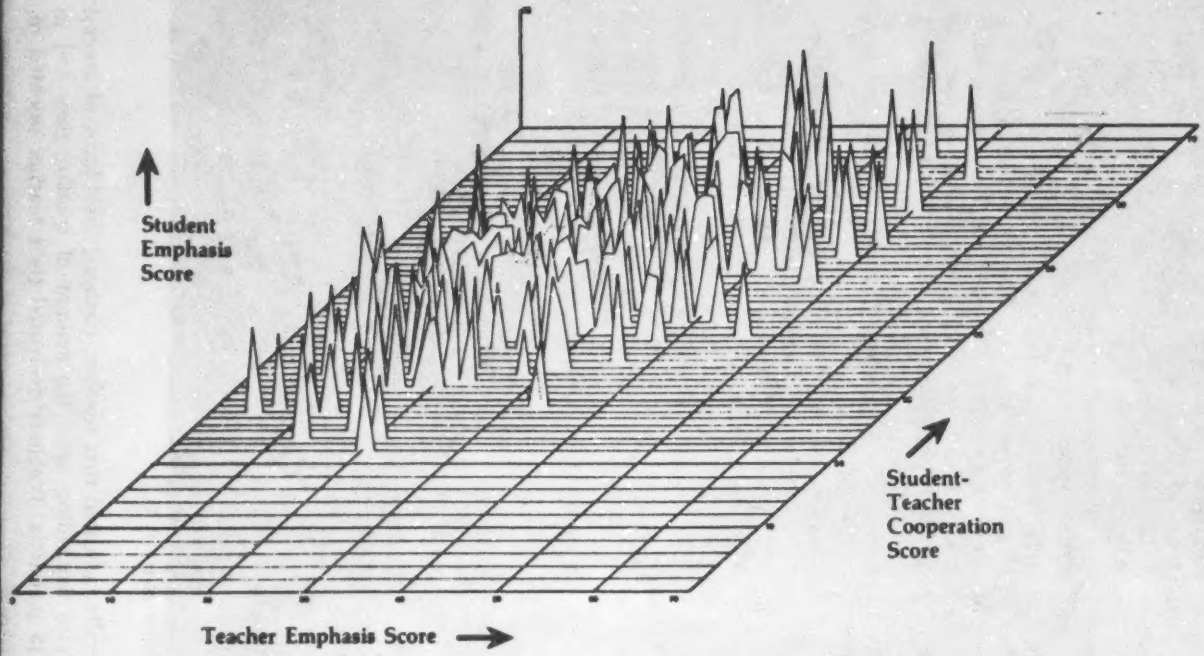

Illustration 3

THREE-DIMENSIONAL SCATTER DIAGRAM OF
PREDICTED ROLE MEASURE SCORES

4) Bartlett's test for independence was used to test for the independence of variables and confirmed the following correlation findings indicating that the variables were not independent.

Correlation of teacher score with student/teacher score was	0.441
Correlation of teacher score with student score was	0.051
Correlation of student/teacher scores with student scores was	0.316

When the multivariate analysis of variance was used to test differences in groups responding to Decisions in Teaching, a significant difference was indicated. Simultaneous T^2 contrasts were used to find which scores contributed to the significance. An alpha of 0.01 was used throughout the remainder of the study.

Study Two: Comparison of teachers' responses before and after instruction in SCIS techniques.

This study was designed to find if teachers changed their patterns of locus of control after two or four weeks of workshop training in the SCIS program. Workshops in Massachusetts, California and North Carolina were involved in this study and responses were gathered from 76 teachers.

A multivariate analysis of variance was carried out on the two groups. As shown in Table 2 the results were significant at the $\alpha < .01$ level. Thus, it would appear that teachers who completed two and four week institutes scored between 4 and 13 points lower on the teacher oriented locus of control measure.

TABLE 2

MULTIVARIATE F VALUE AND SIMULTANEOUS T^2 CONTRASTS FOR THE DIFFERENCE BETWEEN PRE-INSTITUTE TEACHERS' AND POST-INSTITUTE TEACHERS' SCORES

Source	Degrees of Freedom	Multivariate F
Between Groups:	3	10.44*
Residual:	141	
Teacher Oriented Score:	$4.22 \leq \mu$ Pre.I. $- \mu$ Post.I. ≤ 12.93**	
Student/Teacher Cooperation Scores:	$-0.05 \leq \mu$ Pre.I. $- \mu$ Post.I. ≤ 8.49	
Student Oriented Scores:	$-3.40 \leq \mu$ Pre.I. $- \mu$ Post.I. ≤ 5.06	

*Significant at $p < 0.0001$
**Significant at $p < 0.05$

Results indicated that teachers changed their locus of control predictions depending upon the amount of training they had in the SCIS materials. Teachers decreased their teacher oriented re-

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sponses. While encouraging, the results of the investigation could be explained by teachers predisposed to change taking the workshops, while their colleagues who did not take workshops would be quite different. If so, it was argued, this predisposition would be apparent if teachers who took a workshop and teachers who did not take a workshop were compared prior to any education.

Study Three: Comparison of teachers not enrolled in SCIS instruction and teachers prior to starting SCIS instruction.

A sample of 69 teachers starting in SCIS workshops were compared with 51 teachers from the same schools who were not to be involved in workshops. A multivariate analysis of variance comparing the two groups is shown in Table 3.

TABLE 3

MULTIVARIATE F VALUE AND SIMULTANEOUS T^2 CONTRASTS FOR THE DIFFERENCE BETWEEN PRE-INSTITUTE AND NO INSTITUTE TEACHERS' SCORES

Source	Degrees of Freedom	Multivariate F
Between Groups:	3	3.33
Residual:	116	
Teacher Oriented Score:	$-6.98 \leq \mu$ No Inst. $- \mu$ Pre-Inst. ≤ 3.24	
Student/Teacher Cooperation Scores:	$-9.10 \leq \mu$ No Inst. $- \mu$ Pre-Inst. ≤ 0.25	
Student Oriented Score:	$-9.16 \leq \mu$ No Inst. $- \mu$ Pre-Inst. ≤ 0.52	

The results indicated that the two groups could not be differentiated. It did not appear that teachers elected to go to workshops because they were inclined toward the locus of control philosophy of SCIS any more than their colleagues. Could the results be expanded beyond the SCIS curriculum? What of teachers who did not use the SCIS materials but preferred or used activity oriented materials? Could they be compared with teachers who taught science that was presented primarily through printed or book data? Yes!

Study Four: Comparison of teachers using book centered science with teachers using activity centered science.

One hundred twenty teachers in total school groups were compared and it was found that significant differences occurred between the two groups. See Table 4.

The teacher oriented totals were significantly lower for teachers using activity based programs as compared to teachers using text materials.

To this point the studies indicated that the device, Decisions

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TABLE 4

MULTIVARIATE F VALUE AND SIMULTANEOUS T^2 CONTRASTS FOR THE DIFFERENCE BETWEEN BOOK-CENTERED AND ACTIVITY-CENTERED TEACHERS' SCORES

Source	Degrees of Freedom	Multivariate F
Between Groups:	3	5.16*
Residual:	116	
Teacher Oriented Score:	$1.7 \leq \mu$ Book $- \mu$ Act. ≤ 10.9**	
Student/Teacher Cooperation Scores:	$-0.3 \leq \mu$ Book $- \mu$ Act. ≤ 8.6	
Student Oriented Score:	$-1.3 \leq \mu$ Book $- \mu$ Act. ≤ 8.6	

*Significant at $p < 0.001$
**Significant at $p < 0.05$

in Teaching, might be a useful tool in analyzing teacher profiles for three loci of control. Differences in teacher groups were found, and it could be assumed that there would be differences in teacher behavior based on their responses to simulated teaching situations.

Normally, in longitudinal studies regression effects are found. As materials are used, more and more new techniques are sometimes cast aside and old techniques are reinstated. To find if the regression effect operated in this context, further study was done.

Study Five: Comparison of teachers' scores of those finishing instruction in SCIS materials and teachers' scores of those having taught SCIS for at least a year.

Teachers were tested after they had taught the SCIS materials for periods of one or two years and trends were noted. Contrary to a regression model, teachers continued to change their predictions of teaching behavior. See Table 5.

TABLE 5

MULTIVARIATE F VALUE FOR THE DIFFERENCE BETWEEN POST-INSTITUTE AND POST-INSTITUTE + 1 TEACHERS' SCORES

Source	Degrees of Freedom	Multivariate F
Between groups:	3	2.20*
Residual:	117	

*Significant at $p < 0.90$

As can be seen from the multivariate analysis, there appeared to be no significant differences in scores between teachers completing instruction and those having taught for a year.

More interesting is to note the trends in means of various

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groups as the progress in their education of and use of the SCIS program. The results are shown in Table 6.

TABLE 6

MEANS OF GROUPS HAVING VARIOUS TEACHING EXPERIENCE

Group	N	Teacher Oriented	Student/ Teacher Cooperation	Student Oriented
No experience	18	26.5	47.9	49.6
Two-week workshop	13	21.1	45.9	53.3
Four-week workshop	44	19.6	42.7	49.4
At least one year teaching experience	19	15.1	38.5	52.9

A final analysis was made to compare teachers who had used the SCIS program for two or more years with the staff of the SCIS.

Study Six: Comparison of teachers using the SCIS program for one or more years with the SCIS staff.

The results indicated that with increasing involvement with the SCIS materials, teachers' profiles became more and more like those of the SCIS staff. After teaching SCIS for two years, it was not possible to differentiate teachers' responses from those of the SCIS staff. The analysis for this study was different from those of the previous studies. Correlations were made using the order of the preferences of statements on each scene from the film with the theoretical ordering of statements. The scenes were then ranked in order from Most Student Oriented to Least Student Oriented and these rankings then compared. The rankings of 18 staff members of SCIS were indicated in Table 7. Also in Table 7 are the rankings of the responses for the post-instruction plus one year group, the post-instruction group, the pre-instruction group, and the book-centered group.

As was reported before, the study has been replicated with teachers using other activity oriented programs and the results are the same. It appears that involvement with curricular materials that are most activity oriented than had previously been used results in teacher behavior, or at least prediction of teaching behavior, that are less teacher directed and more student directed.

One of the basic assumptions of curricula produced during the 1960's and 1970's under the auspices of national foundations was the assumption that quality curricular materials would change teacher behavior. We now have evidence to support this assumption. Further, it appears that a wide variety of teaching styles may be acceptable for beginning new curricular endeavors. With

TABLE 7

SITUATION PREFERENCES OF GROUPS RESPONDING TO THE PREDICTED ROLE MEASURE

Groups	Book-Centered	Pre-Instrument	Post-Instrument	Post Instrument + 1	SCIS Staff
Most	4	2	2	2	2
	5	5	4	4	4
	7	4	5	5	5
	2	7	1	1	1
	8	8	7	6	7
	6	6	6	7	6
Least	1	1	8	8	8
Student	3	9	3	3	3
Oriented	9	3	9	9	9

adequate training and/or experience teachers can discern the locus of control which is consistent with that of curriculum designers. Future studies may be needed to find if particular types of locus control patterns are naturally derived rather than as an inference from the literature as was done in these studies. Nevertheless, an important step in classroom interaction has been analyzed and clarified.

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XI

A COMPARATIVE ANALYSIS OF TEACHER ATTITUDES IN TWO NATIONAL SCIENCE FOUNDATION IMPLEMENTATION PROGRAMS

GERALD H. KROCKOVER AND HAROLD H. JAUS

Most public schools have made a commitment to the development and implementation of a K-12 science program. Yet, designing these programs to have a reasonable sequential development encompassing grades K-12 has presented many problems. One major roadblock, stated in the 59th Yearbook of the National Society for the Study of Education (1960), has been in achieving a dependable articulation between the elementary and secondary school. The Yearbook states that on many occasions there appears to be a conflict between the educational point of view of the elementary and secondary school teachers. The Yearbook continues by stating that "there is a pressing need for more effective communication between teachers, leading to a clarification of educational views, from one level to the next before we can ever hope for effective articulation" (pp. 107, 309-310).

In addition, Watson and Cooley believe that one of the areas of needed research in science education is in the area of communication between teachers. They state, "Too many science teachers in this country are forced to act as though no one else had ever taught similar classes." They conclude, "Research on such problems should be highly operational, closely tied to schools" (Henry, 1960, pp. 107, 309-310).

Yet, in the 15 years that have elapsed since this need was identified, a survey of the literature reveals a lack of science education studies related to communication between teachers. One such study was conducted by Brown (1974) who found differences between elementary teachers and secondary science teachers in educational attitude, philosophical orientation, and degree of openness or closedness of belief systems (pp. 190-191). Although research on the communication of teachers is lacking, an article by Fertitta (1975) indicates that the need for research in the area of improving communication between teachers for the development of a K-12 science program is still a viable one.

The Study

The purpose of this study was to determine if there were differences in elementary teachers' attitudes toward 1) working with and understanding secondary teachers, 2) teaching at various grade levels, 3) work load, and 4) team teaching. Two groups of

teachers were involved in the study. One group was composed of *only* elementary teachers who attended a National Science Foundation Instructional Improvement Implementation Program for 10 months during 1974-75.* The second group was composed of both elementary and secondary teachers who attended a different National Science Foundation Implementation Program for 10 months during 1974-75.** Both programs consisted of a 4-week summer component and a 9-month academic year component of 36 meetings.

The significance of this study is based upon several assumptions: 1) that communication between elementary and secondary teachers will improve when these teachers are involved in a combined program, 2) that increased perception of elementary and secondary teachers' problems will result when these teachers are involved in a combined program, and 3) that combined elementary-secondary projects will foster the development of viable K-12 science curricula.

An investigator-developed, 15-statement opinionnaire, Science Teacher Opinion Scale - STOS, (shown on following page) was designed to measure the attitudes of elementary teachers toward: 1) working with and understanding secondary teachers (statements 2, 4, 7, 10, 11, and 13), 2) teaching at various grade levels (statements, 5, 6, 12, 14, and 15), 3) work load (statements 1, 3, and 4) team teaching (statements 8 and 9). The subjects responded on a Likert-type scale consisting of five categories, i.e., strongly agree to strongly disagree. The content validity of this measure was judged by four science educators and reliability was determined by the test-retest method with 54 elementary and 15 secondary teachers not involved in this study. A Pearson product-moment coefficient of $r = 0.85$ was obtained. The experimental design for this study was a static group comparison with the scores from each statement of the STOS opinionnaire analyzed by a one-way analysis of variance with two treatment levels (Walker, 1953).

During the summer portion of one NSF Implementation Program, elementary ($n = 26$) and secondary teachers ($n = 20$) were placed in "mixed" teaching teams, e.g., a third grade teacher teamed with a high school physics teacher. These teams then provided science instruction to a group of ten elementary pupils for one week. After each week, for a period of three weeks, new teaching teams were organized; for example, the third grade teacher would now be teamed with a junior high science teacher and the physics teacher teamed with a first grade teacher. Another group consisting of only elementary teachers ($n = 27$) attending a different summer NSF Implementation Program served as the control group. These teachers were also involved in teaching science to

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THE SCIENCE TEACHER OPINION SCALE (STOS)

Direction: This inventory is designed to sample your opinions concerning secondary and elementary science teaching. Read each statement carefully and decide how you feel about it. Circle your choice corresponding to the following scale:

SA = Strongly Agree A = Agree U = Undecided
D = Disagree SD = Strongly Disagree

SA	A	U	D	SD	1.	Since many elementary teachers are rseponsible for all subjects, they should be paid more than secondary science teachers.
SA	A	U	D	SD	2.	Secondary science teachers have fewer discipline problems than elementary teachers.
SA	A	U	D	SD	3.	Elementary teachers work harder than secondary science teachers.
SA	A	U	D	SD	4.	The problems a secondary science teacher has are different from those of an elementary science teacher.
SA	A	U	D	SD	5.	A secondary science teacher could teach effectively in an elementary science classroom.
SA	A	U	D	SD	6.	An elementary science teacher could teach effectively in a secondary science classroom.
SA	A	U	D	SD	7.	Small group instruction is more difficult in a secondary science classroom than in an elementary classroom.
SA	A	U	D	SD	8.	I would enjoy team teaching with a secondary science teacher.
SA	A	U	D	SD	9.	I would enjoy team teaching with an elementary science teacher.
SA	A	U	D	SD	10.	Elementary teachers do not understand what secondary science teachers do.
SA	A	U	D	SD	11.	Secondary science teachers do not understand what elementary science teachers do.
SA	A	U	D	SD	12.	The open classroom concept is not workable at the secondary school level.
SA	A	U	D	SD	13.	Healthy communication between elementary and secondary science teachers is an impossibility.
SA	A	U	D	SD	14.	The idea of teaching elementary school science students frightens me.
SA	A	U	D	SD	15.	The idea of teaching secondary school science frightens me.

small groups of elementary children but the teaching teams consisted of *only* elementary teachers. At the conclusion of the 4-week summer portion of each of the programs both groups were administered the STOS opinionnaire with only the scores from the elementary teachers of both groups being used in the data analysis.

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Findings

The results obtained from the scores of each statement on the STOS test are shown in Table 1. Significant F ratios were obtained from opinionnaire statements 1, 2, 3, 5, 8, and 13. The mean score on statement 1 for the elementary teachers who only team taught

TABLE 1

THE SCIENCE TEACHER OPINION SCALE (STOS)
ONE-WAY ANALYSIS OF VARIANCE

Control Group = (n = 26)		Agree	= 4
Experimental Group = 1		Undecided	= 3
df - Between Groups = (n = 27)		Strongly Agree	= 5
df - Within Groups = 51		Disagree	= 2
df - Total = 53		Strongly Disagree	= 1

Item	Group	Mean	Standard Deviation	F ratio
1	C	2.81	1.47	
	E	1.81	0.85	9.24**
2	C	2.44	1.19	
	E	2.08	0.89	1.61*
3	C	3.78	1.01	
	E	2.50	1.30	15.95**
4	C	3.41	1.34	
	E	3.61	1.06	0.39
5	C	2.63	1.28	
	E	3.11	1.14	2.13*
6	C	2.63	1.21	
	E	2.96	1.00	1.18
7	C	1.96	0.85	
	E	2.08	0.98	0.21
8	C	3.41	1.22	
	E	3.85	0.92	2.17*
9	C	4.11	0.89	
	E	4.23	0.65	0.31
10	C	2.74	1.13	
	E	2.58	1.03	0.31
11	C	3.11	1.15	
	E	2.81	0.94	1.10
12	C	1.81	0.79	
	E	2.08	0.89	1.29
13	C	1.37	0.49	
	E	1.65	0.80	2.45*
14	C	1.52	0.98	0.67
	E	1.69	0.47	
15	C	3.18	1.27	
	E	2.92	1.26	0.57
TOTAL	C	2.73	0.74	
	E	2.66	0.65	0.16

*$p < 0.25$
**$p < 0.005$

with other elementary teachers (control group) was 2.81. The mean score on this same statement for the elementary teachers who team taught with secondary teachers (experimental group) was 1.81. Although neither group was in favor of elementary teachers being paid more money than secondary teachers, the experimental group was significantly more opposed to the idea than the control group. Statement 2 indicated that the experimental group disagreed more strongly that secondary science teachers have fewer discipline problems than elementary teachers. Significant results were also obtained on statement 3 in that the control group with a mean score of 3.78 believed that elementary teachers work harder than secondary teachers. This belief was not held by the experimental teachers who tended to disagree on this statement (mean = 2.50). Statement 5 found the experimental group favoring the notion that secondary science teachers could teach effectively in an elementary science classroom. The experimental teachers agreed that they would enjoy team teaching with a secondary science teacher (statement 8). These results suggest that elementary teachers can be favorably influenced toward recognized secondary teachers' problems and teaching abilities by the "mixed" team teaching spproach.

The control group believed that 1) elementary teachers deserved higher pay and worked harder than secondary teachers, 2) secondary teachers had fewer discipline problems, and 3) secondary teachers could not teach effectively in an elementary classroom. The control group, however, did agree that healthy communication with secondary teachers was not an impossibility (statement 13). This finding indicates that although elementary teachers are not against working with secondary teachers, their understanding of the problems or abilities of secondary teachers is not manifested until a cooperative endeavor with secondary teachers occurs.

Summary and Conclusions

Designing science programs to have a sequential development encompassing grades K-12 is a viable and necessary goal of education. This goal becomes more tenable if effective communication has been developed between elementary and secondary teachers who understand and are cognizant of each others problems, teaching skills, and feelings. Elementary and secondary teachers who have worked together are more likely to design and carry out effective and articulated K-12 science programs than teachers who lack such opportunities.

This study has shown that mixing elementary and secondary teachers in team teaching situations can be an effective means of encouraging inter-grade level communication. This study has also shown that elementary teachers who have taught with secondary school teachers have a more realistic idea of the educational point

of view of the secondary school. In conclusion, it would appear that perhaps one of the best ways to encourage interaction and communication between elementary and secondary teachers in science is to involve them in joint Instructional Improvement Implementation Programs. Perhaps additional evidence can be obtained which will illustrate the usefulness of combined elementary-secondary programs as a viable alternative to isolated elementary and secondary programs. Funding agencies such as the National Science Foundation should give serious thought to providing additional funding for an investigation of the value and usefulness of such efforts. Perhaps then we can attempt to meet one of the goals of science education which was delineated by the National Science Teachers Association publication, *Theory Into Action . . . In Science Curriculum Development* (1964), which is the development and implementation of an articulated and sequential K-12 science curriculum for *all* children.

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XII

ATTITUDE CHANGES OF CLASSROOM TEACHERS COOPERATING WITH THE FIELD COMPONENT OF AN ELEMENTARY SCIENCE METHODS COURSE

MARTHA K. PIPER AND LINDA HOUGH

It is generally acknowledged that elementary teachers' attitudes toward science are less than positive (Shumsky, 1965 and Thomson, 1975). Inservice programs can improve attitudes toward science and science teaching and improved attitudes have been correlated with an increase in teaching activities (Piper, 1973). However, other than inservice programs, very little has been done to explore alternative ways to improve the classroom teacher's attitude toward science.

The Study

The purpose of this study was to explore changes of teachers' attitudes toward teaching science by having them observe science activities being taught in their classrooms by preservice elementary teachers at a nearby university.

The question asked was:

> Do elementary classroom teachers' attitudes toward teaching science change in a positive direction following twelve activities being taught in their classrooms by elementary preservice teachers enrolled in a science methods course?

The subjects of this study were the 13 classroom teachers who cooperated with 36 elementary science methods students who taught activity hands-on science lessons in their classrooms.

The Semantic Differential, as established by Osgood, Suci, and Tannenbaum (1957), was the instrument used to collect data. The Semantic Differential uses a bipolar set of adjectives to determine the perception an individual associates with a concept. Each protocol word or phrase is judged on a 7-step scale in relation to each of 12 pairs of descriptive adjectives. The protocol phrases used in this study were:

1. Science Courses in High School
2. Science as Remembered in Elementary School
3. Science Education Methods Courses
4. Science in the News
5. Teaching Science to Children

The 13 classroom teachers were given the Semantic Differential twice: (1) prior to a 6-week period during which the methods students taught 12 activities in their classrooms and (2) following this 6-week period. The scale, consisting of seven steps, between each of the twelve bipolar adjectives was assigned numerical values from one to seven, one indicating the most positive attitude.

One-way analysis of variance was used to analyze (1) the total responses toward each protocol phrase and (2) the total responses toward each protocol phrase when grouped into the subsets evaluation, potency, and activity. The numbers in the tables which follow indicate (1) the total mean sums for all and (2) the total mean sums for the subsets evaluation, potency, and activity.

Findings

Responses indicated both positive and negative changes over the 6-week period (Table 1). There were statistically significant

TABLE 1

ATTITUDE CHANGES IN ELEMENTARY CLASSROOM TEACHERS FOLLOWING ELEMENTARY SCIENCE METHODS STUDENTS TEACHING IN CLASSROOM

Protocol Phrases		Mean Sum Totals Before (N=13)	Following (N=13)	Probability Level
1. Science in High School	E	11.85	10.92	.62
	P	15.39	14.54	.39
	A	15.69	12.08	.02*
	Total	42.92	37.53	.17
2. Science as Remembered in Elementary School	E	12.61	13.23	.74
	P	15.77	14.31	.32
	A	14.01	13.92	.92
	Total	42.46	41.46	.83
3. Science Education Methods Course	E	11.23	10.39	.56
	P	15.61	14.23	.21
	A	13.39	11.31	.16
	Total	40.23	35.92	.19
4. Science in the News	E	14.92	13.23	.35
	P	15.85	16.31	.70
	A	16.85	15.23	.31
	Total	47.61	44.77	.51
5. Teaching Science to Children	E	14.69	13.08	.47
	P	17.54	14.23	.02*
	A	16.85	12.23	.05*
	Total	49.08	40.54	.10

E (Evaluation)
P (Potency)
A (Activity)

*Level of Significance at .05.

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changes in a negative direction toward Science in High School for the subset activity. There were statistically significant changes in a positive direction toward Teaching Science to Children for the subsets potency and activity.

Summary and Conclusions

The results of this study indicate that classroom teachers' attitudes toward science are more positive following activities taught in their classrooms by preservice teachers. This suggests that there are ways other than the traditional inservice workshop to encourage science teaching in the elementary schools.

Coordinated efforts between school districts and universities to improve science teaching in the elementary schools need a greater emphasis in activities rather than inservice workshops. Preservice teachers need more opportunities to try out science activities in a real classroom environment. On the other hand, inservice teachers need more opportunities to observe new teaching strategies and activities they might use in their own teaching.

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XIII

SUMMARY AND CONCLUSIONS

The reluctance of elementary teachers to teach science has long been noted in the history of the elementary curriculum and is a primary deterrent to the teaching of any science program. Shumsky (1965) has called science the stepchild of the elementary curriculum.

One of the major reasons cited for the reluctance of elementary teachers to teach science is their negative attitudes toward science. These attitudes appear to have developed over a long period of time beginning in elementary school classes (Ritz, 1968), continuing in high school and college science courses (Hurd and Gallagher, 1968), and culminating in preservice science methods courses (Goodlad, 1965). Teachers who enter the profession with predisposed negative attitudes toward science unfortunately transmit these attitudes to their students who in turn begin another cycle of negative attitudes toward science (Allison and Smith, 1974).

The search for variables that affect preservice elementary teachers' attitudes toward science has generally revolved around three main areas: 1) the various designs of elementary science methods courses, e.g., inclusion or exclusion of a field component; 2) personal characteristics, e.g., age and sex; and, 3) professional characteristics, e.g., hours of science content taken in college.

There have been a number of researchers concerned with the development of a science methods course which would develop positive attitudes of preservice elementary teachers toward science. Strawitz (1976) used 82 elementary majors to assess the effects of an activity-centered science methods course on attitudes toward science. Activities for the treatment group were drawn from ESS and SCIS. There were positive attitudes following the methods course. The treatment group responded that science is something children *do*. Two factors that appeared to influence more positive attitudes were the students *doing activities and practicing them with children.*

Similarly, Allison and Smith (1974) investigated attitudes toward science of preservice elementary teachers participating in an activity-oriented science methods course using concrete experiences, instructor modeling, and field experiences. In addition, the science methods course was competency-based. These combined factors developed positive attitudes toward science. The investigation of Piper (1976) as reported in the monograph also found positive attitudes toward science following a very similar methods course.

Todd (1958) was one of the first to investigate attitude differences toward science between males and females. Todd found that

females' attitutes toward science were more negative than males'. It was suspected this was due to the feeling that science was not suitable for females. A more recent study by Shrigley (1974) and Piper (1976) with preservice elementary teachers did not find that females were more negative toward science than males. This may indicate that today females are far less intimidated in choosing science as a field of interest.

The effects of educational background of preservice elementary teachers have been investigated as a factor in influencing attitudes toward science. In 1969 Barretto used 300 preservice elementary teachers to measure attitudes toward science. It was found that preservice teachers with the greater number of semester hours of college science responded with positive attitudes toward science than those with fewer semester hours of college science. On the other hand, Shrigley (1973) found a low correlation between science knowledge and attitudes toward science of preservice elementary teachers. Shrigley concluded that more science content courses may not mean more positive attitudes toward science. More investigation is needed before prescribing additional science courses for elementary science teachers. It may be that the kind of science courses prescribed is more important than the number. Most of the science courses offered do not take into consideration the needs of the elementary science teacher. Christiansen (1971) suggested:

> If an increased achievement level is desired, the addition of more science courses does not appear to be the only solution. Perhaps interdisciplinary courses employing a broader scope and sequence would provide the preservice elementary teacher with science experiences without isolating the areas of science between courses . . . If teachers are to obtain positive attitudes toward science, and security with its content, it is imperative for the Science Department which teaches the content courses, and the Education Department which teaches the methods courses to work jointly in establishing a science program which is directed toward these ends.

The Science Department and the Education Department at the University of Houston collaborated to design a course titled Physics Course for the Elementary Teacher. The course improved attitudes toward science as reported in this monograph (Piper, Moore, 1976).

Research on inservice teachers' attitudes toward science has also concentrated on the development of effective science programs. Pempek and Blick (1973) investigated the effects of inser-

vice teachers' participation in an inquiry-oriented science program upon their attitudes toward science. The experimental group used SAPA, SCIS, and ESS materials for actual teaching experiences in the classroom. Pempek and Blick found that the experimental group exhibited a statistically significant positive change in their attitude toward science. The control group did not show a change in attitudes toward science.

Another study by Chapman (1971) involved hands-on activities drawn from SCIS, ESS, and SAPA. The investigation sought to determine the effect of a 6-week summer program on inservice elementary teachers. The difference between Chapman's and Pempek's studies was that the 6-week summer program did not include any actual teaching experience with the science materials in classrooms. No significant change in attitudes of inservice teachers toward science was found. This seems to indicate that a field component is a factor in influencing positive attitudes toward science. DeBruin and Moore (1976) studies support this conclusion.

Piper (1974) explored the effects of a televised science inservice program on attitudes of inservice teachers. The television program was competency-based, and the activities and materials used were drawn from the SAPA program. Actual teaching experiences were part of the design of the inservice program. The study indicated that increased science competency as well as an increase in science activities taught in the classroom were correlated with improved attitudes toward science. Piper and Hough (1976) found that inservice teachers' attitudes were more positive toward science when given the opportunity to observe others teach science in their classrooms.

As with the preservice teacher, there is no agreement in the research as to the science content background an elementary teacher needs to develop positive attitudes toward science. Some studies such as Butts and Raun (1970) found the teacher who had few hours of science or none were more positive toward activity-oriented science than teachers with a greater number of course hours in science. Other studies including Schurwian (1969) and Shrigley (1973) made a contrasting observation; inservice elementary teachers with the greater number of semester hours of science were more positive toward science than those with fewer hours of science content.

Teachers, when asked about their needs, did list insufficient science knowledge as a barrier to effective science teaching. Maben (1973) conducted a study to obtain information from inservice elementary teachers concerning the difficulty certain factors offered to effective science teaching. Insufficient science knowledge and lack of inservice opportunities were two of the most important factors listed. As with preservice teachers, it may be that elementary

teachers recognize their need for more science knowledge but the science courses they take do not give them the background knowledge to teach science in the elementary schools.

Rubin (1971) states that a teacher's willingness to teach a topic is inseparable from attitude toward the subject; and attitude, in turn, is related to the teacher's competency in the subject area. Therefore, teachers who acquire competence in science, i.e., fundamental science knowledge and science methodology skills, should acquire more positive attitudes toward science.

The results of an investigation of the educational background of inservice elementary teachers in Texas (Moore, 1975) is not atypical from the rest of the country. At least 5 percent of the teachers reporting had never had a science methods course or a science content course. In addition, 20 percent of the teachers had their last science methods course more than 10 years ago and 33 percent had their last science content course 10 years ago. Teachers responding to the Moore Assessment Profile (Moore, 1976) listed Teaching the basic scientific fundamentals and Training in science teaching methodology as 2 and 4 respectively in a list of 13 factor needs. Thus, the data from the status report and the perceived science needs of teachers indicate that educational background in science content and methodology is not sufficient to encourage teaching of science in the classroom. A feeling of inadequacy develops poor attitudes and if teachers have poor attitudes toward science, their students will likely reflect similar attitudes.

The evidence from the studies cited indicate that whether the teachers are preservice or inservice, certain factors stand out as being important considerations to investigate as programs are being designed to improve attitudes and prepare elementary teachers to effectively teach science. These factors are:

1. More collaboration between science departments and science educators would produce science courses designed specifically for the elementary teacher population. Such courses would improve elementary teachers' attitudes toward science as well as increase their science knowledge.

2. An inservice science workshop or a preservice science methods course should have objectives that are stated in terms of what a competent elementary science teacher should demonstrate teaching science in the classroom. Teachers, inservice and preservice, continue to ask how to teach—not what to teach. A structured training program does not stifle originality and creativity in teaching children. It provides the foundational structure that builds confidence and positive attitudes from whence new ideas spring.
3. The instructional leaders of an inservice workshop or science methods course should model the teaching strategies that a teacher can use in the classroom. One of the primary needs of science

teachers teaching hands-on activities is classroom management. Telling a teacher about it is not enough. Teachers need to see and be a part of these strategies so that they in turn can practice with children.

4. Teachers need to practice with children in classroom situations. Peer teaching or tutoring small groups of children using hands-on activities does not give a teacher realistic practice in classroom management strategies. Grouping, passing around materials, and children interacting with each other often create havoc in a classroom, and without experience a teacher may develop negative attitudes. Teachers indicate they need practical suggestions as to how to begin an activity, how to ask open-ended questions, how to group children, how to disperse materials, how to synthesize with the children the data from the activity, and finally how to evaluate the lesson.

Science educators designing programs for preservice and inservice teachers should look at research data to identify factors that affect skills and attitudes in teaching science. This monograph brings to light additional research data to encourage science educators to continue in the search for ways to improve science teaching in the elementary schools.

MKP, Editor